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INDIANA UNIVERSITY

VISUAL ENVIRONMENT FOR SCHOOLROOMS

by

Paul W. Seagers

with

PROCEEDINGS OF THE
INDIANA ILLUMINATION CONFERENCE

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TABLE OF CONTENTS

	Page
Visual Environment for Schoolrooms, by Paul W. Seagers	5
Introduction	5
Seeing-Learning	6
Daylight	8
Planned Lighting	10
Color	12
Conclusions	19
Bibliography	19
Indiana Illumination Conference: Program	23
Proceedings of the Indiana Illumination Conference	26
Statement of Needs, by Deane Walker and Virgil Stinebaugh	26
Buoyant Surroundings for Children, by Wendell W. Wright	28
Development Hazards of the School, by D. B. Harmon	31
Health and Development Problems of the School Child, by Dwain N. Walcher	36
Vision, Learning, and Adjustment: Symposium, by N. C. Kephart, John H. Waterman, and Irvin M. Borish	40
The Relationship Between Visual Environment and Health, by Dean Smiley	49
Selection and Installation of Good Classroom Luminaires, by Russell C. Putnam	51
Requirements of Design for the Curriculum: Round-table Discussion, by B. L. Dodds, Frank E. Allen, Ralph Legeman, and Edward E. Simmons	55
Lighting and Equipping the Coordinated Classroom, by D. B. Harmon	60

FOREWORD

When originally planned, this bulletin was to cover rather comprehensively the field of visual environment in schools. As the Indiana Illumination Conference was being organized and there was recognized a need for the publication of the proceedings, it was decided that, as a contribution to this important conference, a rather large portion of this bulletin should be devoted to the condensed proceedings of the conference. Thus, the original bulletin has been reduced to the point where it stresses only some of the more important features of seeing-learning in a balanced visual environment and suggests some practical ways of obtaining that balance. There are already many excellent bulletins and articles on the mechanics of seeing and of balanced brightnesses in the visual fields, so this publication will be a little more concerned with the totality of the process, giving considerable emphasis to the psychological side.

PAUL W. SEAGERS

VISUAL ENVIRONMENT FOR SCHOOLROOMS

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Introduction

During the first half of this century considerable progress has been made in providing the proper visual environment in schoolrooms. Before the days of artificial illumination in school buildings, the pupils would study as long as they could see, and when it became too dark, recess would be called or the children would engage in some other activity. Then oil lamps were introduced for dark periods; later gasoline lamps were used; and finally one bright electric lamp was hung in the middle of the room. With closer work and a greater variety of subjects, more exposed lamps were introduced until at least two, and sometimes four, were found in the room.

The next era was the era of glass-enclosing globes and frosted lamps. As the need for more close work was recognized and more people experienced eye strain and wore glasses, the tendency was to increase the wattage in each glass-enclosing globe and hang a minimum of four fixtures to a room. Attention was then focused upon the foot candles or intensity of light. The intensity was increased from 8 to 12 foot candles and in some cases even to 20 foot candles of artificial light for the average classroom.

In the 1920's a few frontier thinkers and scientists began a more thorough investigation of the effect of various light intensities upon seeing ability. The research was increased materially in the 1930's, resulting in a new shape of globe which diffused better and directed more light onto the ceiling.

In the late 1930's and early 1940's the Illuminating Engineering Society, the National Council on Schoolhouse Construction, Nela Park, and other agencies began considerable research in visual comfort and efficiency. Schisms occurred as one group championed greater intensities and another group championed the balancing of brightnesses within the surrounds. The development of the fluorescent lamp complicated the problems greatly. The results were greater awareness of the need of controlling daylight, of the comfort-discomfort threshold of glass globes, of the differences in incandescent and fluorescent lighting, of the balanced brightnesses in the visual field, and of the practical limits to the use of high intensities. The experiments in Texas also pointed toward a new consideration—the effects of light and glare upon the physical body.

I believe we are now crossing the threshold of another era in illumination, brought about by a change in classroom methods and a realization that the whole child goes to school. This concept is based upon the psychological consideration of light and color, not as separate entities but rather as cooperating agents to provide the proper social,

emotional, mental, and physical environment for the great variety of tasks conceivably performed in the classroom of tomorrow.

It is the purpose of this bulletin to explore some of the latest research on illumination, including a very neglected phase, color. An attempt will be made to explain the theory of illumination in as non-technical language as possible without the aid of charts and diagrams. Throughout the bulletin will be found reasonable principles and examples of good practice which can be applied with success in normal situations.

Seeing-Learning

Seeing is a very complicated task because so many factors influence the process. Among the factors to be considered are the size of the object, the clarity of its outline, the distance at which it is viewed, its brightness as compared with its background, its position in the field of vision, the source of light, the amount or intensity of light, and the direction of that light as well as of other light sources and brightnesses in the field of vision. In addition, the condition of the viewing organism, including the actual structure of the eye, certainly is important.

The past experience of the person doing the seeing influences both the acuity and the rapidity of sight. If the eye is normal structurally and functionally, how much a person sees may also be influenced by his emotional ability, both at the time of his first experience with this particular seeing task as well as at the time of his present experience. In other words, if we associate any particular scene with a repugnant experience, a subsequent seeing of that general scene will give the same emotional reaction, even though the details within that scene may be somewhat different. The emotional stress of the individual may prevent the person from seeing the details. The view of a magnolia garden in the moonlight when associated with a pleasurable embrace to seal an engagement is a different view from that in the same garden with the same moonlight if a rejection of one's affection takes place. Interestingly enough, it will take considerable relearning to erase the particular emotional counterpart of that visual experience so as to get what we might call an objective evaluation of the scene.

The normal person gets more knowledge of his environment through sight than through any of his other senses. This knowledge does not come through a mere series of pictures of his environment, but rather through a continuous interpretation of the varying brightnesses and of outlines and their positions in the total visual field. The total visual field can normally be thought of as embracing about 160 degrees horizontally and 120 degrees vertically. At the very center of this field is the focal field, approximately a one-degree field on which the eyes are focused at the moment for critical seeing. Outside of this, and having the same center, is the central field which includes the visual task, like a printed page, a section of the chalkboard, or any other object that is being seen. Immediately around this field is the surrounding field which is similar to a 60-degree cone centering on the line of sight. Making up the rest of the visual field is the peripheral field, in which critical seeing plays no important part but within which

balanced brightnesses must be considered carefully. In any seeing-learning situation, interpretation takes place. Learning is an activity which embraces the functioning of the whole person, the organism as a complete entity socially, emotionally, physically, and mentally. Thus, we see that seeing-learning is not just a mechanical situation similar to taking a photograph.

A person's first experience in seeing involves brightness and outline, and then he grasps solids such as rattles, blocks, and balls, and his knowledge of his new three-dimensional world comes through the association of his various experiences in this world of solids. His further meaningful experiences progress no faster than his total organism matures and becomes prepared for them in an environment conducive to seeing-learning. When a child is just about getting adjusted to his world of height, width, and depth in which he has had complete freedom in bodily movement, he is thrust into a more confined environment, the schoolroom, where not only his bodily movements are restricted but he is forced to limit most of his visual experiences to planes and surfaces covered with queer looking marks and characters.

It is true that looking at photographs and pictures helps in the transition from his normal world of height, width, and depth to this artificial world of height and width only, and certainly color aids materially in that transition. Nevertheless, without a doubt the child undergoes considerable stress and many conflicts unless there is proper preparation for the jump into his new two-dimensional symbolic world. To force him to try to interpret or read without the proper balancing of the various conditioning factors not only is a waste of human energy, but may also condition him emotionally so that further learning to read may be very difficult. On the other hand, if all the other factors, including the maturation or readiness of the individual, whether physical or psychological, are favorable, reading becomes a pleasurable experience and may develop with great rapidity.

The process of seeing-learning and the eventual preparation of the organism to act is an energy-consuming process. A large proportion of the total body energy is used for this purpose. Large amounts of energy are also used to keep the body in a healthy working condition, as well as to keep it in motion. Any extraneous factor in the environment which requires large amounts of body energy for adjustment deprives the body of those quantities of energy normally used for seeing-learning, body repair, growth and health, and motion. Therefore, if one attempts to see under adverse conditions, the extra energy used for that task may be taken away from the action stock pile of energy or the health and growth stock pile of energy. Poor lighting conditions, including excessive brightness and glare, not only can cause fatigue but also may cause functional and structural defects in the body if the seeing motive is dominant. If the health, body repair, or action motives are dominant, not enough energy goes into the seeing-learning process, which is thus slowed up, with a resulting appearance of low mental application or ability. Further information can be obtained concerning this phase of seeing-learning by reading some of the excellent bulletins and articles listed in the bibliography.

To summarize, the seeing-learning process involves the whole organism functioning in its visual environment. Ideally, the visual balance of the environment should be such as to require a minimum expenditure of bodily energy for the process. Any approach to illumination other than on the basis of the totality of the seeing-learning process is fractional and cannot be considered adequate.

Daylight

Daylight, originally the source of light for most of our visual tasks, has required reinforcement as our society requires longer hours of close visual work. The change in emphasis on use of daylight has taken place to the degree that in many situations the original source of light, or daylight, has been relegated to a minor position, and in some cases has been considered a nuisance or a source of annoyance. For day-school purposes, it is still considered a major factor in the total visual environment. Some use it as a primary source of illumination for visual tasks, while others want it merely for psychological reasons.

As a primary source of illumination, daylight is difficult to control except in those rooms oriented toward the north. At times the surface brightness of the windows exceeds all standards set up by the American Standards Association. At other times the glare from the sun cannot be tolerated. Efforts to overcome some of these difficulties are partially successful. Shades hung at the top of the window cut out the most useful light first and are not recommended. Overlapping or light shielded translucent shades hung at the middle of the window, so that one shade pulls up and the other down, gives rather good control of glare at a great cost of intensity and even of distribution of light. Single shades which are hung on ropes and can be adjusted to various positions have about the same efficiency as the double shades mentioned above. Venetian blinds control the light with greater efficiency but are a great maintenance problem.

To be more efficient, venetian blinds should be hung in pairs at the middle of the window with one set operating up and the other down. The common venetian blind would be more efficient if the lower half could be adjusted or tilted separately from the upper half, with, of course, a light baffle between the two halves. Vertical venetian blinds are rather new. Although they may present much less of a maintenance problem than the regular venetian blinds, they do not reflect the light onto the ceiling, which is an important function of a venetian blind. The use of these blinds also has a tendency to limit somewhat the seating arrangement in the classroom. Glass cloth baffles, and light shields hung at an angle to the upper part of the window reflect considerable light onto the ceiling and properly diffuse much of the remaining light. These have been found fairly successful where there is a minimum of dust in the air, but at best they create maintenance problems.

Sometimes the peculiar structure of the building itself helps in light control. For instance, a roof projection or overhang, or a type of outside baffle or outrigger, will keep the direct rays of the sun

from the classroom during school hours and yet let considerable light into the room. Combinations of overhangs and jib walls are found excellent for certain orientations. Some school systems find prismatic glass brick very effective when extended from a level of about six feet to the ceiling. Vision strips of clear glass below the glass block are recessed towards the room, so that the structural member supporting the glass block also keeps the direct rays of the sun from the pupils' desks. There is no question but that this treatment refracts much of the light across the room and onto the ceiling. There are times during the day, however, when there appears to be an excessive surface brightness. No doubt improvements in the manufacture of glass blocks will do away with this objection.

More natural light can be provided by varying the roof construction on single-story buildings or the top floor of a multi-story building. When properly constructed, the clerestory roof will allow light to enter the room on a level well above the field of vision. When used with light baffles, overhangs, or outriggers, the surface glare is minimized and the light is directed onto the ceiling. Monitor roofs will provide even more light for the dark inside half of the classroom, and this is important as the rooms tend to become more square or exceed the former standards of 22 feet in width. A conventional skylight is usually a source of glare and annoyance and therefore is not recommended.

Adjacent bilateral lighting may be used rather successfully in the kindergarten and first grade, or in other places where large amounts of activity take place. This type of lighting limits materially the flexibility of rooms where there is considerable study or close work. Window mullions and piers should be very narrow, and window sills should never be lower than the eyes of the seated pupils, except for kindergarten and other areas of activity. A safe height for window sills is 36 inches for classes up to and including the sixth grade, and 42 inches for those above the sixth grade. Orienting the rooms to the north eliminates some of the problems of glare, but it also precludes a schoolroom from receiving some sunshine at some time during the day, an argument frequently used for east or west orientation.

In some sections of the United States, to get the recommended levels of intensity it is necessary to use artificial light most of the day. If it were not for the fact that there may be some merit in the contention that natural light is desirable in classrooms housing growing children, it might be profitably excluded in these regions. Dr. Harmon's talk, found in the proceedings section of this bulletin, indicates that an equal energy source of light is necessary for the manipulation of growing children and that, furthermore, artificial lighting should be supplemental to natural. He also feels that the changing pattern of natural light is very desirable. If it were not for these contentions, perhaps we would design a classroom with no windows but with illuminated out-of-door scenes to provide the desirable psychological effects and preclude the feeling of claustrophobia.

Thus, we see there is no one answer to the use and control of daylight in classrooms. Geographical locations, maintenance policies, atti-

tudes towards unique styles of architecture, wealth, and one's philosophy of education will have much to do with determining the type and degree of use and control of natural light.

Planned Lighting

Planned lighting is more than introducing a quantity of artificial light into a room. It is the balancing of the elements of the visual environment to the point where the human organism can obtain optimum performance with a minimum expenditure of bodily energy. Even though color is an important part of this environment, for purpose of ease of explanation we will treat it more fully in the following section. The visual environment is composed of the source of light and the surrounds. The source may be natural, artificial, or a combination of both. As natural light, or daylight, was discussed in the previous chapter, it will seldom be referred to in this chapter.

The modern source of artificial light is the electric lamp or tube, and may be either incandescent or fluorescent in type. The incandescent lamp has been in use for many years, so many, in fact, that we have become quite accustomed to seeing objects in its yellowish light. To view objects under any other artificial light color or light temperature at first seems rather fantastic or garish. The incandescent light is simple, requires no accessories, and needs only to be replaced after burning out. It converts much of its energy consumption into heat and therefore, when used in too great a number or wattage, it can cause excessive heat discomfiture and overburdening of the ventilating system during a cooling season. So far as the light is concerned, this lamp has all the characteristics of good light; however, it uses a little more than twice the amount of current that a fluorescent lamp consumes for the same light output.

The fluorescent lamp or tube radiates light because of the activation of phosphors within the tube. Various combinations of these phosphors give various degree tubes, such as 3500, 4500, and 6000. The 3500-degree tube gives off light more in the yellow range, while the 6000 radiates more in the blue range. These tubes give off little heat and are more than twice as efficient as the incandescent as far as energy consumption is concerned. The light is of a good quality and is not harmful when the lamps are properly installed. The standard fluorescent tube is four feet long, has two pins at each end, and requires a ballast or transformer and a starter. It presents a maintenance problem because a failure to light can be caused by any one or any combination of three things: the lamp, the ballast, or the starter.

Tubes can now be purchased in a variety of lengths, usually four feet, six feet, or eight feet, and in standard or low brightness. There is also a slim-line tube which requires no starter and has only one pin or contact point at each end. There is also a heavy duty or cold cathode tube which has an effective life of about 10,000 hours and should be used in places difficult to reach for replacement. The regular tubes can now be purchased with a 3,000-hour life. The total tube life can be materially shortened by frequent starting; thus it is usually

more economical to leave lights on rather than to turn them off with slight changes in room intensities. For this reason the use of automatic control with these lamps is not feasible. A tube is rated after it has been in use about 100 hours; therefore, when first put into use, it will appear much brighter than when rated.

When a bare lamp or tube is suspended within the visual field, it causes discomfort because of its brightness or glare. At this time no tube in general use should be used bare. There is some experimentation in using a bare cold cathode tube at half its rating, but that is still in the experimental stage and cannot be recommended for general practice. Thus, all tubes and lamps should function in fixtures or luminaires with shields, baffles, or egg crates. Lighting fixtures are usually classified according to their general light pattern. This is the amount of light sent upward or downward. The direct lighting fixture directs from 90 to 100 per cent of its light downward and from 10 to 0 per cent of its light upward. This can be used for local task lighting or accent lighting, but should never be used for general lighting in a classroom, as it produces too much glare and shadow. The semi-direct fixture permits 90 to 60 per cent of the light to go downward and 10 to 40 per cent of the light to go upward. These may be used in locker rooms and corridors, but are not adaptable to classrooms. The general diffusing fixture sends 60 to 40 per cent of the light downward and 40 to 60 per cent upward. This light also produces glare and shadow and is not suitable for the classroom. The semi-indirect light sends about 40 to 10 per cent of the light downward and 60 to 90 per cent of the light upward. Under proper shielding conditions, this type of light is satisfactory for classroom use. The indirect light directs 10 to 0 per cent of the light downward and 90 to 100 per cent of the light upward, so that the ceiling becomes the main reflective source of light. These fixtures are the least efficient of all fixtures, but give the highest quality of light. A slightly translucent fixture is better than one that is entirely opaque, because it minimizes the brightness difference between the fixture itself and the illuminated ceiling.

In the selection of fixtures it is important to select one with a surface brightness not to exceed 450 foot-lamberts when viewed from any normal standing or sitting position. The shielding, or cut-off, of a fluorescent fixture should be at least 45 degrees when viewed lengthwise of the fixture. A 45-degree cut-off crosswise is desirable, but 35 degrees may be found entirely satisfactory. The fixtures should be well built and properly finished for a maximum amount of reflection with a minimum amount of glare. Replaceable parts, such as ballasts and sockets, should be bolted to the fixture. The highest quality parts and accessories should be used.

Good tubes of the new 4500-degree type or the soft white type should be used. Psychologically, it is not good to mix different degree tubes. For incandescent lighting the plastic helmet and concentric ring fixtures are desirable. The regular silver-bowl lamp should be used in a concentric ring fixture. Fixtures should be installed in such a manner that the ceiling will be properly illuminated. The levels of illumination recommended in the Illuminating Engineering Society

Handbook of 1947 are as follows: classrooms, including study halls, libraries, shops, lecture rooms, and laboratories, 30 foot candles maintained; sight-saving classrooms, drafting rooms, and sewing rooms, 50 foot candles maintained; gymnasiums and swimming pools, 20 foot candles; auditoriums, cafeterias, and similar rooms, not used for study, 10 foot candles; reception rooms, locker rooms, stairways, and corridors containing lockers, 10 foot candles; and corridors and storerooms, 5 foot candles.

Increasing the intensity of light in a room without any consideration of the environment in which the light is to function is very poor practice. Good light environment not only reflects light properly, making it work efficiently, but also provides a minimum of brightness difference in the visual field so that the eyes do not have to try constantly to accommodate to extremes in brightness. Frequently in churches the stained glass windows seem too bright for comfort, when the real difficulty is the extreme difference in brightness between the stained glass window and the dark window trim and walls. Considerable body energy is used in trying to accommodate to these conditions, and thus fatigue sets in. If the trim and walls are painted a light color or tint, the difficulty ceases. The recommended brightness differences or brightness ratio limits for classrooms, as set up in the 1947 Illuminating Engineering Society *Handbook*, are as follows: task and immediate background, such as desk top, wall, and so forth, 1 to 3 or 3 to 1; task and more remote parts of the room, 1 to 10 or 10 to 1; the light source, that is the luminaire or sky and adjacent ceiling or wall, 1 to 20 or 20 to 1. In no case should the ratio be combined to suggest the acceptability of a range greater than 1 to 30 or 30 to 1.

Since to determine brightness requires a rather expensive instrument and a trained observer, the recommended procedure is to select colors and finishes on the basis of their light reflection factors, or the percentage of light which they will reflect. If they are selected in accordance with the recommendations of the National Council on Schoolhouse Construction, which are listed below, the brightness differences of the surrounds will be well within the approved limits. The ceiling should have a light reflection factor of 85 per cent or better; the walls 60 per cent or better; the dado or wainscot, 40 per cent or better; all trim 40 to 60 per cent reflection factor; floors, desk, and other equipment, 30 to 40 per cent reflection factor; and chalkboards, 20 to 25 per cent reflection factor.

Thus we see that planned lighting actually involves the proper selection of finishes for the surrounds as well as the proper selection and installation of the luminaires or light source. Intensity of illumination is only a part of the whole visual environment, and in many instances it may even be secondary to the balancing of the brightnesses within the visual field.

Color

The purpose of a discussion of color is to focus attention on the trends of thought in prescribing color for school interiors. It is thought desirable to review the findings and writings of selected recognized

specialists consisting of the illuminating engineers, a psycho-physiologist, a doctor of medicine interested in psychology, color specialists, and interior decorators.

In the previous chapter we have seen that the illuminating engineer is much more interested in the reflectance values of color and the brightnesses between various colors than he is in the specific colors. On page 4-2 of the Illuminating Engineering Society *Handbook*, 1947, it says, "since taste and emotional reactions are involved in any evaluation of the results, it is probable that the solution of aesthetic design problems will continue to be based in good part on experience and judgment for some time."

In contrast to the lighting engineer, Harmon (14)* feels that "when general light levels reach those now represented by currently recommended practices, the color sense in vision has certain physiological and psycho-physical functions or expressions seemingly independent of those of the light sense." He further states that the human eye is not color corrected, and this lack of correction makes for the physiological processes expressed as the "psychological effects of warm and cool, stimulating and relaxing, approaching and receding colors." Thus people are conditioned to color likes and dislikes. This is important because "poorly chosen colors for classrooms, as represented by both color of background and color temperature of incident light, can hamper, if not damage, the development and achievement of children in school. If background colors are too saturated, or if the task-incident light peaks too much at some wave length, the accommodation forced by the dominant luminosity of these colors can interfere with the accommodation, or latitude of accommodation, required by the task." He further expresses his idea that background colors in classrooms should be more apparent than real. They should be more or less grayed out without being drab, and their reflected light "should distribute well over the spectrum with their apparent color tending to be near the center of it, varying only enough to compensate for room orientation and light differences due to exposure . . . . Background colors should not conflict with color in the purposeful materials of the child's experiences in learning situations. They should, rather, help give these colors full value, so that each color experience of the child will be as near optimum as can be attained."

Even though the psychology of color is rather complex, Dr. Podolsky (30) has found some unanimity of opinion in regard to the effects of color upon the human body. He has found that we are affected constantly by the color of our surroundings and that, although different people are affected in different ways, it is very important that the right color combinations are selected for our surroundings both for our own health and for our efficiency. He believes that injudicious color combinations will work havoc with our well-being. He quotes a number of instances where people have become ill from the wrong hues and states that suicides from the Blackfriars bridge in London were reduced considerably when that gloomy structure was painted a

* See numbered bibliography, pp. 19-21.

bright green. He also recounts the story of girls who felt much colder at a temperature of 75 degrees F. in a cold slate blue office than at 72 degrees F. in the same office after it was repainted a warm yellow.

It is reported that Dr. Fere, studying the effects of colored light upon muscular activity, found that the muscular activity under red light was nearly twice that found under ordinary light, while Dr. Pressey found that the mental processes of a person took up 20 per cent more time under the influence of a cold color than of a warm color. Further experimentation showed that green and blue should be used where working conditions involve heat and high temperature, while the warmer colors should be used in places where the temperature must be kept low for purposes of manufacture.

Dr. Podolsky cites more specific effects of color as follows: "Bright pure colors should be used sparingly and judiciously, care being taken not to throw the general impression of the room, that is, stimulation or sedation, off balance. Blue is magnetic, soothing, cooling, and stimulates concentration. Sunlight yellow is a mental stimulant. Spring green is a fine mental sedative. Cardinal red is of value in extreme cases of mental depression. Rose color is a mental recuperative. Yellow will stimulate without exciting. White is a cheering color which attracts sunlight, but if used alone is cold. Brown is restful and warming in quality, but if used alone it tends to have a depressing effect. Purple and mauve are sedative and soothing and seductive of sleep. Gold is a bright, cheerful color, useful in convalescence, while grey depresses and suggests cold." He also states that in the minds of certain peoples and races certain colors suggest definite qualities and characteristics, "thus red may stand for action and courage, but also anarchy and carnage. Pure yellow suggests cheerfulness, glory, prosperity, and sunlight, while in some people it suggests shoddiness, disease, and cowardice. To some people purple may be the color of royalty, magnificence, and heroism, and to others suggests passion, mystery, and suffering."

It is interesting to note that blue has always been the favorite color of men, red has had the most attraction for women. Athletes of both sexes favor red. Intellectuals have a decided preference for blue, and egotists have a passion for yellow. The lovelorn gravitate toward red. Children invariably prefer bright, gay, and flashy colors, as well as do members of the negro race. The elderly prefer black, dull grays, and browns. In China, white is the color of mourning, while it suggests purity and cheerfulness to an American. In Japan red is the symbolic color of fire and destruction, while it is extremely popular in India. Thus Dr. Podolsky cautions us to use the proper combination of colors, not only because of the particular orientation of the rooms, but also because it gives us a definite net psychological result.

As a color specialist, Abbott (1) has attempted to establish some color principles. First he suggests that "color can have good effects if it is applied with knowledge, but it will possibly have bad effects if it is misapplied. Effective treatment of any disorder by means of color is a complex science, involving a considerable knowledge of the patient's physical and mental condition and of the power of color."

Because of the particular emotions evolved by color treatment, even for normal beings, the selection of color is very complex.

Color has the qualities of hue, value, and chroma. "Hue refers to the basic sensation" of color; value refers to its brightness or darkness; and chroma refers to its purity of color, strength, or saturation, that is, the extent to which it is adulterated with any other color or with black or white. Tone refers to its grayness, shade to the extent to which it is mixed with black, and tint to the extent to which it is mixed with white. As certain colors are commonly recognized as advancing colors and others as receding colors, their nature must be taken into consideration in room decoration. For instance, painting the end walls of a long, narrow room a receding or cool color will make the room seem even more narrow.

After taking into account the effect of the receding, neutral, and advancing colors, it is desirable that the full composition of colors in a room be harmonious, that the room feel settled, and that some degree of satisfaction be given to the observer. Abbott states that harmonies can be effected by the use of, first, any one color in different values (shades and tints); second, any two colors that are complementary or analogous (analogous meaning close together in the color circle); third, any three colors that are equidistant on the color wheel, or any three colors that are analogous; fourth, any number of colors, including both complementary and analogous colors in any number of shades and tints, provided that the relative brilliance corresponds with that of the spectrum. Black, white, gray, glass, gold, silver, and so forth, do not clash with any colors and can often accompany them with pleasing effect.

Abbott also suggests that discords, which are the opposite of harmonies, are never justifiable in any large doses, but that perhaps in some small quantities they may tone down and prevent rich harmonies from being too sweet. Discords frequently are highlights in nature. He says also that larger masses are more pleasing when they are brighter and less pure than the accompanying smaller masses. Outlining a lighter color with a darker color emphasizes it and gives it greater brilliance. White tends to lighten and cool adjacent colors and to make them appear stronger, while black has the opposite effect. Color intensity does not seem to increase with increased illumination. In fact, color appears more vivid under moderate illumination than it does under very strong illumination. Bright sunlight devitalizes color and makes more desirable the use of saturated colors in strong contrast in nature. This is especially true in the tropics, where the sunlight is very brilliant and nature displays its gaudiest colors in greatest contrast. Thus, the more brilliantly a room is completely lighted, the more necessary it is to get greater color intensities for a desired result.

Even though most color experts may use different terms for the effects of color, the following four terms more or less sum them up: stimulating, relaxing, neutral, and depressing. The actual threshold between any two of these is not so definite as to prevent the same colors from having slightly different effects on different people, and

a very slight change in any particular color can completely change its psychological effect.

Bustanoby (6) goes more into the historic development of color and the discovery of pigments and their mixing to get the desired hue. Most of the color experts agree with the Munsell system of color balance; in other words the colors which you use in the room, when placed in the same proportion as you wish to use them on the color wheel, should give a net value of gray, or complete neutralization of each other.

In a paper presented before the Illuminating Engineering Society, Miller and Reynolds (22) state that there is another quality which should be taken into consideration; that is, the finish of the reflecting surface or the radiating quality of the color. Color appearance depends to some extent upon whether the surface is smooth, rough, or glazed. This is extremely important when directional lighting is used rather than general diffused lighting on the surface. They also bring out the idea that in living we no longer think in terms of rooms, but rather of living areas. To develop into normal, healthy people, those living areas should reflect opportunity for security, self-expression, satisfaction, and socialization. They point out the fact that artificial light reflected from white ceilings tends to draw color from floor covering and upholstery fabrics. Therefore, in order to make any particular color give off its greatest value at floor level, the ceiling should be such a color as to reflect the artificial light down onto the floor color.

Miller and Reynolds also say that, to provide the maximum sense of space, walls and woodwork should be painted the same color, preferably a light, cool color. It is not necessary to have all walls of the same material. In other words, they can be brick, wood, painted, or papered, and still have the same color; nevertheless, each material is of a different value and texture and therefore needs a different type of lighting.

A severe contrast between colors should be avoided; however, it has been found that to sensitive people dark contrasts against light backgrounds are less fatiguing than light contrasts against dark backgrounds. Probably the simplest color arrangement is to use shades and tints of one color for all the areas, and to bring in enough other color accents to prevent monotony within the room. They also point out that acceptance of new color combinations is becoming greater today because of our magazines, movies, and advertising. They especially feel that some way "must be found to assemble and correlate the experiences of decorators, designers, and lighting specialists of unusual ability, who instinctively use new materials, colors, and ideas without fully recognizing why or how." A study of the relationship of this whole area must be continued, according to them, so that it can be made available on a practical basis.

In his color preference studies, Buck (4) points out that in nearly all lighting practice there is the intent to direct one's attention to the objects in the environment rather than to the light sources. He especially brings out the fact "that the color impression of an object is affected not only by the spectral character of the source, but also by

the surroundings and by the physiological and psychological characteristics of the observer as conditioned by his past history. Consequently, while one can establish the degree of preference of a large group, individuals will differ. He is especially interested in color preference from the point of view of using the proper lamps. As all objects get their colors primarily from light (if the so-called color of the object is not present in the light the object will appear black), it is only necessary to state further that the proper lighting sources must be available to get the desired color.

The Public Buildings Administration of our Federal Works Agency has made a two-year study jointly with the Public Health Service (8) and has proved to those making the experiment that, when a proper color is introduced into a machine room, there is a greater speed-up of work and fewer mistakes. It was also found that the colors of the machines had to blend into the colors selected for the walls, floor, and trim. Colors with high reflection factors were selected for this experiment.

The University of Minnesota (17) has made great strides in studying the color schemes for its buildings. To sum up some of their work, they omit dados of any sort whenever possible and use them only where the walls are to be painted in light colors, in which case they make them very dark by contrast. If the location of the wall is such that it does not become soiled too easily, they darken the light tones as much as possible and paint the entire wall one color. In some places they use very dark tones, such as gunmetal from floor to ceiling, and then they use lacquer red, or brilliant yellow green, or some such bright color on an adjoining wall as a color foil. They have found out that they must sharpen their color tones as the colors darken in value, and that they must frequently relieve the monotony of long corridors by the use of advancing or retreating colors placed at intervals at the ends or at corridor junctions. They do not use drop ceilings nor colored ceilings. They feel that the use of colored ceilings should be left to the expert among experts. Their experience in the cooperative planning of colors has not been very satisfactory, because "with all of us we do not know what we like and we like what we know." It has been their experience that, after using certain general principles in setting up their color designs, people learn to like their work.

In contrast to the work at the University of Minnesota, the cooperative scheme of planning color for school interiors was employed at St. Paul, Minnesota (29). They used a variety of hues and values, and dark colors were not arbitrarily ruled out. As they stated, dark colors "are useful sometimes on small areas to provide accentuation in the color scheme, a momentary eye-rest surface, or a background, and occasionally for a principal color in the total color scheme." They also carried white on the side walls and ceilings of those rooms that seemed to have too low ceilings. In a long, narrow room the two end walls were drawn in by painting them a more intense color than the side walls. It is also interesting to note that they claim to have taken into consideration the detrimental effects of differences in bright-

ness values. This is rather unusual because most interior decorators and people having to do with art run the gamut from black to white in setting up color schemes. It is a little difficult to reconcile this with a statement in which they say that occasionally dark colors are used as a principal color in the total color scheme. It is also interesting to note that they have recognized the fact that only guiding principles can be set up and that these guiding principles must be administered with judgment and experience, though they send an advisory committee to the various buildings to assist in planning the color schemes.

As we see from the foregoing material, there is not as much disagreement in the use of color in schools among the various experts as might be thought. It can probably be concluded that in the old fashioned classrooms it is most desirable to have a high reflection factor throughout the room in accordance with the recommendations of the Illuminating Engineering Society and also to keep the brightness differences within the maximum prescribed in their manual. Beyond that, there is little that one can do except to introduce various colors in the accessories, such as furniture, pictures, plants, and screens to do away with the monotony of one particular color. Under no consideration does it seem desirable to have all the colors neutralize each other in accordance with the Munsell system, because it is thought psychologically correct to have some residue of color to produce the desired effect upon the human body.

If the classroom is of a newer type and is set up with interest in work, play, and study areas, the over-all color can conform to the requirements of the Illuminating Engineering Society. The interior of the various interest centers can be decorated with a greater view to the artistic and can incorporate even darker colors and shades than those prescribed for good illumination, providing those colors and shades do not come within the field of vision during study and do not absorb the light necessary for the study area.

It may be also desirable to think of the surfaces in terms of different types of materials, using combinations of plaster, wood, brick, stone, celotex, and decorators' burlap in color. These various textures can relieve the monotony of a large room and help to give it a more buoyant atmosphere if consideration of the types of materials figures into the illuminating job. The proper use of approaching and receding colors, both in corridors and classrooms, can give the feeling of spaciousness and coziness and can do away with the sense of being institutionalized.

Various psychological factors of color, as mentioned by Dr. Podolsky and others, should be given great consideration in the decorations of the room. In fact, it seems very logical that, in the preliminary planning of the building, various standards of color treatment should be set up and the areas to receive the various types of treatment should be studied before the general architecture of the building is planned. There is little reason why the techniques of high contrast, task, and side lighting used by the sales specialist and window decorator to feature various objects cannot be used in various areas of the school. It appears necessary that this type of lighting and contrast

be kept out of a person's field of vision only under normal study conditions. With the planning of a building in terms of areas, it appears that we can take full advantage of the experience and study of all the experts interested in color, from the illuminating engineer to the psychologist to the interior decorator and to the sales specialist.

Conclusions

1. Seeing-learning is a complicated process, involving the whole organism and requiring a large amount of body energy.
2. Conditions which require too much energy for seeing-learning may deplete the energy commonly used for other purposes in the body and thus hamper body functions.
3. Even though daylight is difficult and expensive to control, it is thought desirable in schoolrooms housing growing children.
4. Planned lighting involves the balancing of all the brightnesses within the field of vision, regardless of whether they are from light sources or from the surrounds.
5. The brightnesses in the surrounds can be balanced by selecting finishes with the recommended reflection factors.
6. The recommended levels of intensity should be met only in connection with the proper balancing of the surrounds.
7. No bare lamps or tubes should ever be allowed in the normal field of vision.
8. The luminaire should be hung so as to direct considerable quantities of light onto the ceiling in a pattern free from shadows.
9. Fluorescent luminaires should be well constructed, should be equipped with approved ballasts and starters, and should have a minimum shielding of 45 degrees lengthwise and 35 degrees crosswise.
10. The modern classroom should be flexible and should therefore contain no luminaires which require a specific seating pattern.
11. The color selected for a classroom depends greatly upon its use and orientation. As a general rule, warm colors should be used on cool exposures or in rooms requiring stimulation, while cool colors should be used in rooms having warm exposures or requiring rest and relaxation.
12. Accent colors used should be complementary to the general or predominant color scheme, thus, blue bookcases can be used in a room having camellia walls.
13. Setting up a balanced visual environment, in the selection of both luminaires and color, is a complicated task and requires the services of a specialist.

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INDIANA ILLUMINATION CONFERENCE

Program

DATE: March 31 and April 1, 1950

PLACE: School of Medicine, Indiana University, Indianapolis, Indiana

THEME: Providing visual surroundings for the whole child, physically, mentally, socially, and emotionally

PURPOSE: To bring before engineers, architects, and school officials the latest developments and practices in good quality and quantity lighting of classrooms in order to close up the gap of years between sound theory and practice

SPONSORS: Indiana State Department of Public Instruction, Purdue University, Indiana University, and the Indianapolis School Corporation

PAUL W. SEAGERS, *General Chairman*

GROUPS INVITED TO COOPERATE

Indiana School Boards Association, Indiana State Teachers Association, Indiana Town and City School Administrators Association, Indiana County Superintendents Association, Indiana Township Trustees Association, Purchasing Agents Association of Indianapolis, Indiana Medical Society, Indiana Society of Ophthalmologists, Indiana Society of Optometrists, and the Indiana Chapters of the American Institute of Architects, American Institute of Electrical Engineers, and Illuminating Engineering Society

Friday, March 31st

9:30 a.m. Registration

10:00 a.m. H. L. Smith, *presiding*
"Statement on Needs," Deane Walker and Virgil Stinebaugh
"Buoyant Surroundings for Children," Wendell W. Wright
"Development Hazards of the School," D. B. Harmon

12:30 p.m. Luncheon

2:00 p.m. H. L. Harshman, *presiding*
Welcome by John D. Van Nuys, M.D.
"Health and Development Problems of School Children," Dwain N. Walcher, M.D.
"Symposium, Vision, Learning, and Adjustment," LeGrand H. Hardy, M.D.; N. C. Kephart; John H. Waterman, M.D.; Irvin M. Borish, O.D.

4:30 p.m. Visitation of schools to view good lighting. (Buses will be available.)

6:30 p.m. Dinner meeting at Athenaeum Turners Club, 401 East Michigan St., Paul W. Seagers, *presiding*
"Relationship Between Visual Environment and Health," Dean Smiley, M.D.

Saturday, April 1st

9:00 a.m. Clarence Pound, *presiding*
"Selection and Installation of Good Classroom Luminaires," Russell C. Putnam
Round-table discussion, "Requirements of Design for the Curriculum," B. L. Dodds, Ralph Legeman, Frank E. Allen, Edward E. Simmons

12:30 p.m. Luncheon
"Lighting and Equipping the Coordinated Classroom," D. B. Harmon

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Committees

PLACE OF MEETING AND LUNCHEONS
John D. Van Nuys and T. F. Schlaegel

DINNER Ross Brown

TRANSPORTATION TO SCHOOLS
Ross Brown

RECEPTION AND REGISTRATION
George H. Bush, H. P. Bettge, Deane Walker, Virgil Stinebaugh, Harold Church

PUBLICITY Ross Bartley

SCHOOL VISITATION
M. V. Bailey, H. L. Harshman, E. P. Bardwell

GENERAL CHAIRMAN AND PROGRAM
Paul W. Seagers

Who's Who Among the Speakers

ALLEN, FRANK E.	Superintendent of Schools, South Bend, Indiana
BORISH, IRVIN M., O.D.	Optometrist, Kokomo, Indiana
DODDS, B. L.	Director Division of Education and Applied Psychology, Purdue University, Lafayette, Indiana
HARDY, LEGRAND H., M.D.	Director Knapp Memorial Laboratory of the Institute of Ophthalmology, Columbia University Medical Center, New York City
HARMON, D. B.	Educational Consultant, formerly Director School Services, Texas State Department of Health, Austin, Texas
HARSHMAN, H. L.	Assistant Superintendent of Schools, Indianapolis, Indiana
KEPHART, N. C.	Professor of Psychology, Purdue University, Lafayette, Indiana
LEGEMAN, RALPH	Architect, Evansville, Indiana
POUND, CLARENCE A.	Professor of Rural Education, Purdue University, Lafayette, Indiana
PUTNAM, RUSSELL C.	Professor of Illumination, Case Institute of Technology, Cleveland, Ohio
SEAGERS, PAUL W.	School Building Planning Consultant, School of Education, Indiana University, Bloomington, Indiana
SIMMONS, EDWARD E., A.I.A.	Architect, Indianapolis, Indiana
SMILEY, DEAN, M.D.	Executive Director Association of American Medical Colleges, Chicago, Illinois
SMITH, H. L.	Director Division of Schoolhouse Construction, Indiana State Department of Public Instruction, Indianapolis, Indiana
STINEBAUGH, VIRGIL	Superintendent of Schools, Indianapolis, Indiana
VAN NUYS, JOHN D., M.D.	Dean, School of Medicine, Indiana University, Indianapolis, Indiana
WALCHER, DWAIN N., M.D.	Assistant Professor of Pediatrics, School of Medicine, Indiana University, Indianapolis, Indiana
WALKER, DEANE	State Superintendent of Public Instruction, Indianapolis, Indiana
WATERMAN, JOHN H., M.D.	Director Child Guidance Clinic, Medical Center, Indianapolis, Indiana
WRIGHT, WENDELL W.	Dean, School of Education, Indiana University, Bloomington, Indiana

PROCEEDINGS OF THE INDIANA ILLUMINATION CONFERENCE

Statement of Needs

HENRY LESTER SMITH, Presiding: I wish to express our appreciation to the Medical School of Indiana University for being our host for this conference and to the various other universities and agencies that have helped to make this conference possible. I also want to express our appreciation to Dr. Seagers for managing and directing the conference to what will, no doubt, be a successful conclusion. The program is full of a great many different topics and approaches to school illumination, so, to conserve time, I will make my remarks and introductions very short.

The first topic to be discussed is the "Statement of Needs." I think we are very fortunate in having two speakers who have had experience in the teaching profession from the ground up, that is, from actual classroom teaching to administration at very high levels. I take great pleasure in introducing to you Mr. Deane Walker who is our present Superintendent of Public Instruction for the State of Indiana.

DEANE WALKER: Thank you Dr. Smith and members of the conference. I am very sure that you do not expect Virgil Stinebaugh and myself to exhaust the topic of needs in illumination. I shall confine most of my remarks to our needs on a state level. This year we have 666,139 boys and girls in Indiana in grades 1 through 12. That is approximately 17,000 more than we had last year. We have every right to expect about the same increase next year, which will exceed the previous top record of school enrollment in Indiana, which was 668,000 for the school year 1933-1934. We can expect increases every year for the next five years, though perhaps not on such a high level, but the State Board of Health tells us that the birth rate is not leveling off as anticipated.

You can see we are going to have very great problems in our already overcrowded classrooms. In fact this increase in enrollment is going to necessitate at least 450 new classrooms each year, to say nothing about replacement of worn-out and obsolete buildings. In other words, we need to spend $10,000,000 a year for the next ten years just to house the new pupils in the State of Indiana. If we add to this the amount of money necessary to replace obsolete school plants, it appears that Indiana will have to spend $150,000,000 on school buildings before 1960.

As you know, we have a 2 per cent constitutional debt limitation which can provide only a small amount of the necessary finances for school buildings. In addition to this, the state legislature has provided means by which school corporations can set up cumulative building funds. I believe that approximately $25,000,000 are already in the cumulative building funds in the various school corporations of this state. Since July 1, 1949, we have received approximately 200 requests

for approval of school plans; 115 of these have been approved and the others are now being processed. They vary all the way from a low of $5,000 to a high of over $1,000,000. The total amount would approximate $9,000,000 in school plants.

I can remember when we used to build schoolhouses of a block type, where the rooms were, in fact, little square boxes and very little attention was given to the service rooms and special classrooms. Sometimes we used to build a school plant and cut it up into classrooms. Today this whole process is much more complicated. The school plant must be constructed to take care of our new type of educational program and sometimes the service rooms and special rooms are even more important than the regular classrooms. The Health Clinic, the cafeteria, the auditorium, the library, the art and music rooms are all important parts of the modern school building. We have long talked about visual aids in the form of motion pictures, lantern slides, and filmstrips, but today we are confronted with the use of radio and even television in the new type of classroom. Of course we must not forget about a gymnasium, especially in the state of Indiana. However, we do not need to worry much about that, as the general public will see that that phase is well taken care of.

This conference is taking into consideration one of the most important aspects of the modern school plant—proper seeing conditions. I feel sure that, by attacking this whole problem of lighting from the viewpoint of the many specialists, we will be able to do a much better job. In fact we have a big job to do when you stop to think that we must plan these buildings to be used for the next 10 or 15 years, or perhaps even 50 or 100 years.

I bring you the greetings from the State Department of Public Instruction, and hope that this conference today and tomorrow will have a profound influence upon the planning of school buildings here in Indiana.

VIRGIL STINEBAUGH: All that Deane Walker has just said about the state of Indiana can be applied to the city of Indianapolis directly with the ratio of ten to one. Whatever Indiana needs, Indianapolis needs one tenth of it. It was very interesting to me to see how closely the pattern of the two coincide. Our studies show that Indianapolis needs approximately 200 additional classrooms within the next three years, and we are now 100 classrooms behind. We have had our ups and downs in pupil population in the past. As certain crests of the waves of population moved through the school system, there were corresponding troughs which helped to compensate for the crest.

Things are different now, we have had five successive years of high birth rates, and it is conceivable that we can have two or three more years of high birth rates, which would put considerably more children in every grade of the whole eight-grade span. We will soon be needing elementary classrooms in a quantity such as we have never dreamed of before. Then that wave will carry through the high school. I, personally, can see no end to this tremendous increase.

I also want to emphasize the fact that the environment influences learning significantly, and, after all, learning is the important activity

that should be taking place around a school. That is why we are organized; that is why we administer schools; that is why we have these physical facilities; and that is why we need lighting. In fact, there are times when we need darkness for audio-visual education rather than lighting. When we need light we need the right amount, and when we need darkness we need the right degree of darkness.

I have attended a number of lighting conferences, and I still see the need for considerable leadership in this whole area on a local level. Conferences like this can help to develop that leadership and stimulate the thinking of all of us in regard to the proper school environment for children, including illumination. During these two days we should move forward perceptibly in the analysis of this important problem and should find some reasonable solutions. We must realize that learning requires certain external stimuli, many of which react through the eyes. It is true that we must depend upon the ears and the sense of touch, and perhaps upon other senses, but we primarily depend upon the eyes. We are so much concerned with what we want boys and girls to see that frequently we are not aware of the fact that their environment is sometimes such that they cannot see the things we put before them.

Suppose we should increase the efficiency of lighting and balanced brightness to the point that the boys and girls in inadequately lighted classrooms might be able to see a tenth more than they see now and see it clearly without fatigue or eye strain. That would be a worthwhile increase in efficiency. It is conceivable that the whole learning process could be stepped up 10 per cent. That in itself would be a great return on the money invested, even if no consideration were given to the fact that pupils would be given greater freedom from eye strain and fatigue. We could easily use as a slogan for this conference "Let there be light, the right amount, the right intensity, the right diffusion, and the right environment for that light, and learning will be moved forward because of these facts." The need, as I see it, is more local leadership in the field of illumination, more intensive study in the application of the information we already have on illumination, and more light on the subject of light.

Buoyant Surroundings for Children

by

WENDELL W. WRIGHT

The Honorable Winston Churchill, in speaking to the House of Commons concerning the rebuilding of that historic building after the war, used this phrase: "We shape our buildings and they in turn shape our lives." In much the same way, we might say we determine the surroundings for our children and thus, to a marked degree, determine their lives.

We are now in an era in which we feel that all environment educates. I believe that the growth and development of the child is con-

ditioned by his surroundings, in the broad sense, and may help determine the kind of person the child will become. I am not unaware of the limitations of this concept. However, as a school teacher, I must live in that faith, and I have lived long enough to have my belief in the concept justified. I believe that the influences at the child level extend to adult life, and that many of the patterns of behavior which we have in adult life are those taken on in childhood. Incidentally, I do not believe that all of our behavior patterns are fixed by the time we are four years of age. To be a human being at four years of age, a child must have patterns of behavior. My belief is that these patterns will be constantly conditioned throughout life with constantly less conditioning as one grows older. At our age there is perhaps little reconditioning of these patterns, and yet I am not too positive that we are entirely hopeless.

The surroundings of children are many. Certainly not the least of these are human beings—parents, teachers, friends, etc. However, since this is a conference on illumination, through lighting, I choose not to discuss illumination through parents and teachers, to say nothing of grandparents. Since I have served, or am currently serving in all of these capacities, I would prefer not to discuss illumination from these angles. Nevertheless, whatever I might say on the subject I would certainly apply to these human beings.

I believe we would agree that we would like to give children at the various levels of their development those influences which would help them become the kind of persons we want them to be when they grow up. Do we want cheerful people living in a cheerful environment? Do we want people to be clean? Do we want people to have good physical and mental health habits? Do we want people who can work together? Do we want people who believe in honest and hard work? Do we want people who have a full realization of democratic life with its stern obligations, its standards of achievement, and its privileges? To these and many other such questions, I feel sure we would answer "yes."

If we want these qualities in grownups, I cannot reason that we should not provide them for children. I cannot believe we get cheerfulness through harsh and drab surroundings. I cannot believe we set the pattern of cleanliness in dirty surroundings. I cannot believe we achieve good habits of physical and mental health under opposite surroundings. I cannot believe we get the best results of natural group work without movable schoolroom equipment. I find it difficult to think we can develop much natural appreciation of beauty by being constantly in the presence of things which are crude and ugly. I cannot believe we can develop much natural individual and group poise without some practice in it. I cannot believe we can develop much deep-seated feeling for democratic life out of dictatorship.

A few years ago, we made a school survey in a city here in Indiana. There were four elementary schools in this city, all built around the turn of the century. The predicted school population increase was only slight. I suppose that, if money were no object, all four buildings might well have been replaced by new structures. However, financial

limitations made this impossible. It was our recommendation, in this particular situation, that the money available be used in making over the drab elementary classrooms into somewhat modern ones.

Under the leadership of an able superintendent of schools that recommendation has been carried out. This superintendent began by modernizing the first grade rooms the first year, the second grade rooms the second year, and so on. I have gone back there to see those schools from time to time. I just cannot make myself believe that they are the same rooms. In terms of the surroundings they are not. All the dark seats which were fastened to the floor were discarded and replaced by light-colored movable furniture. The floors were sanded down to their natural color. The walls were painted in bright colors, and even the blackboards took on a grey-blue hue. Good lights were installed, and attractive shades made their appearance at the windows.

If anybody had told me such a change of material surroundings would remake a school I would not have believed it. Interestingly enough, it seemed that every other factor changed with these new surroundings. Interest picked up in many ways. The attractive reading corners, the new bulletin boards, the new lighting, the "new look" of light-colored floors, green chalk boards, worktables, and desks gave charm, new life, and warmth to rooms which had previously been drab and uninteresting.

In another elementary classroom, there is a special place I think they call their "beautiful corner." This is a kind of sacred place where there is always something of simple beauty. Sometimes it is a picture, sometimes a beautiful arrangement of vases or plants. Whenever I pass that room, I cannot resist pausing for a moment to see that spot. Many times I have seen children in groups of two and three just standing and looking at the beautiful corner. Perhaps a spot of simple beauty in the work-a-day classroom is a bit of buoyant surrounding which is important.

A good many years ago, I read a story about a young man who worked in a small town. He was an electrician and sold lamps for homes. Everybody came to depend upon him. They came to buy their floor lamps and light fixtures from him. He always installed them. He was a wizard at his work and so his fame spread. One day a representative for a big lamp-making industry approached him with an invitation that he join the company. He was offered much more money than he could make in his own small shop, working alone, but he turned down their offer. The company sent the "big shot" to see him, but the lad's answer still was "no." Finally, he explained his refusal to accept their offer, saying, "Here I influence peoples' lives with the kind of light I give them. I make families more congenial; I make homes more beautiful; I make children happier. With the lamps and lights I install, I am doing something for my people. I am doing more than selling lamps and light fixtures. I am bringing light into their lives."

In this conference you will be discussing not only better classroom luminaires, improved vision, and modern lighting equipment, but, as you succeed in getting these into operation, you will be making buoyant surroundings for children.

Development Hazards of the School

by

D. B. HARMON

My particular field of interest in this lighting problem, or school plant problem, is derived from an interest in the learning process. My field is education, experimental education. A number of years ago I became interested in the physiological aspects of learning, so I might say that my interest is the psychophysics of learning. I have been particularly interested in the relationship that certain health problems have to that psychophysics, first as a teacher, then as a research worker in the field of education, and finally as a research administrator in public health. I could not give up the feeling that we human beings are as innately handicapped as a good many of our vital statistics, or educational statistics, would imply. When we explore what has been done in the field of lighting, as far as visual problems are concerned, we find that most of our research has been directed towards illumination for recognition or identification. It has been directed towards illuminating task areas and the immediate surroundings to make it possible for us to identify rapidly something we are supposed to have already learned.

We have been concerned with a very small area of the total visual apparatus in all of this research. We have been concerned with it in a more or less static way, because, being interested in identification and recognition of detail, we let a number of educational assumptions creep in which are not accepted today as being true. When we talk about task lighting and immediate surrounds, and the limits of that particular lighting, we imply that the child is still under the influence of that old educational philosophy of passive absorption. We also imply that he is working at fixed seats, and that he is going to stay in one position or on one type of task. We imply that by some process he will automatically get an insight into the material as we illuminate the details. In addition, we imply that he is a two-dimensional organism, because our effort is directed toward illuminating the task on a two-dimensional plane, and in two-dimensional surroundings. Almost every move that we make toward bettering his illumination denies our fundamental philosophy of learning; that is, that the child learns through activity and that he is a three-dimensional organism moving through space to make some adaptation and acquire some insight so that he can project his manipulation to the future.

The Yale Clinic on Child Development has recently done some very interesting work on the problems of vision or what vision is all about. If a child actually learns to see only that which he is organically equipped to see, he will visualize only a whiteness projection. His eye is apparently a light meter used for evaluating brightness differences within certain limits of their significance to his economy. His eye mechanism is also hooked up with the rest of the organism in such a manner that it sets the person into action to establish some

type of balance with that light distribution. Of course, in a part of the eye he has a mechanism where he can get certain refinements of that light distribution. He can bring out certain details of the total distribution pattern in order to direct their final performance in doing something about those details.

When we get over into meaningful seeing, however, we find that meaningful seeing is actually learning. A child actually has to learn what objects are, what their structure is, what their contours are, what their ,placement in space is, and what their significance is to his survival both socially and physically. Meaningful seeing is more and more showing itself to be a system of balances that the child establishes with the light energy in his modality. The recognition of differences in some parts of the light pattern and the association of those differences with the perceptions derived from other modalities all enter into the total pattern of visual experiences. So learning through seeing is not derived merely from the identification of details limited to a two-dimensional area and space. Learning through seeing is derived from establishing certain three-dimensional balances or equilibria with the light distribution pattern in three dimensions and establishing those balances so that the child is free to get the greatest amount of manipulation of those essential details that are of significance to the course of study and his own organic, psychological, and social economy. In other words, the child learns to see effectively, positively, and constructively by being able to come to balance with the total light energy in his vision, and to maintain that balance with a minimum of effort so that he has a maximum equation to manipulate the things that are presented to him for learning purposes.

A number of years ago I was asked by the Texas State Department of Health to direct a field study on reducing the incidences of visual difficulties in school children by first preventing them. We were given technicians from 39 different specializations, ranging from pediatrics to ophthalmology. We went out and measured, remeasured, and measured again the total of 160,000 school children performing in over 4,000 classrooms. We found the children were in some instances seriously visually handicapped as far as the tasks of the school were concerned, though they did not all need glasses. We found between 55 and 60 per cent of the children with demonstrable visual difficulties that were reducing their ability to perform, not necessarily to recognize but to perform in relation to close visual-centered tasks presented to them by the course instructor. We found those difficulties increasing through time. We also found large numbers of our children handicapped with energy problems, which we will call nutrition problems. This latter problem ran up to about 70 per cent of the group which we studied. We also found approximately 35 per cent handicapped with problems of body mechanics that were directly related to the things they were asked to manipulate. These ranged all the way from downright orthopedic problems to functional posture problems. We found large numbers of them with dental problems which were handicapping them in their education, either by altering their nutritional status or by altering their actual physical approach to the task.

This is only a small list of the handicaps which we found affecting these children as far as educational performance is concerned. Of the 160,000 children examined, we did not find one physically fit according to combined standards of all the specialists we had in the field. In fact, we found those children were leaving the sixth grade with an average of a little more than four problems per child. Later investigations in Vermont, around Chicago, in England, Mexico, and other areas showed about the same results. Next we compared the data with information obtained from children who did not go to school, or who, if they did attend school, were limited to about four weeks out of each calendar year. These children, who had chronological ages comparable to the school ages that we were studying, were the children of the itinerant workers whom we were able to round up by the several thousand.

When we took all the visual problems affecting children who have just started to school for the first time, we found that only about 20 per cent were visually handicapped as far as the tasks of the school were concerned.

When we studied children two and one half years above that age, we found approximately 40 per cent were handicapped, and among those still another two and one half years older we found the number had doubled again and was now 80 per cent. In other words visual problems reducing achievements in school were doubling every two and one half years to the end of the fifth grade. Let me stress again, the children who needed glasses because of anatomical difficulties were not included. The children who were handicapped with body mechanics problems at the beginning of the first grade represented only 7 per cent of the group, and at the end of the sixth grade had gone up to approximately 36 per cent. When we divided our nutritional problems according to demonstrable causes, we found that about one third of these children had their problems because of inadequate diets, one third because of some other difficulty that was interfering with metabolism, and the remaining one third for no other reason than that they were under stress under some adaptive situation. They were developing conditions of malnutrition that were increasing directly with attendance in school. It seems that children with visual problems also frequently had nutritional problems, children with dental problems also had visual problems, children with both of these had posture problems, and so on. In other words, there seemed to be some significant relationship between these various problems, which pointed toward a common cause. It seemed that the human mechanism had a common pattern for adaptive difficulties.

Then we checked those difficulties that increased through time, checking the children who were attending school with those who were not attending school. The children of itinerant workers had visual problems amounting to 20 per cent of the group regardless of the age, whether they were 6, 7, or 12 years old. It must be said that they had terrific nutritional problems, but these were because of an inadequate diet or other metabolic problems. Their posture problems stayed relatively constant from year to year. From this it seems that, if one

wants to set up a course of preventive activity in public health, the best way is to close the schoolhouse and keep the children out of school. In other words, the problems of those children, other than the original 20 per cent, seem to have been brought about by conditions in the school.

We went back to the classrooms and began watching the performances of the children to see whether we could find a solution. Our observations and test situations tended to indicate that we were running into problems of body mechanics involving total performance in relation to light. We were running into growth and developmental problems related to the child's over-all performance towards some stimulus, whatever it might be. So we began digging into basic principles of growth and development as it affects school children and the basic performance as related to physical energies in these groups. I think we have enough evidence now, from our various researches in child development, to make two or three statements. One of them is that the organic child grows towards a symmetrically balanced organism; that is, he is just as much a functioning youngster on one side as on the other side of a perpendicular line running through the center of his body. He is growing in that particular manner because he is actually setting up a set of coordinates on which to function in relation to his three-dimensional surrounds. He is growing towards a bisymmetrically balanced organism structured to function on a system of coordination based on that divisional structure laid down by the growth pattern.

The next thing I think it is safe to say is that the growth process can be fairly well summed up in the statement that the child grows along the line of stress to reduce stress. Physiological adaptation is essentially not very different from psychological. We adopt a pattern of behavior in order to escape attention-producing situations. We go in a certain direction in order to reduce the stress, whether it is biochemical due to lack of growth, or whether it is biophysical due to some stimulus from our environment. So, in structuring artificial environment all the way from a physical classroom to a course of study, it is possible for us to set up activities that utilize only partial systems of the organism and to use them in manners that have centers different from those that are related to this over-all growth process, and thus wind up with a structural defect.

When we study the child as a physical organism in a physical surround, we find that his primary job, as a principle organism, is to come to terms with certain energies and physical limits in his surrounds and to establish balances with those energies and limits as determined by the relation which those energies or limits have to his survival. We find that he has built into his organism certain reflex mechanisms which see that those balances or behaviors toward balance are set into action. Some of these have dominance over others, depending upon the significance of the energy. In other words, as an organism this child's principal job is survival in his surrounds, and he has built into his structure certain mechanisms to promote that survival. For instance, he has a balancing mechanism for gravity,

another balancing mechanism for light, and still another for sound. In choosing the balances between light, for instance, and the balance with gravity, it may be that he will put particular stress in certain areas of his body mechanism.

Learning through activity, organically, is taking certain parts of the mass pattern of the organism and coming into balance with the surrounds, and directing that into discreet activities which are not inconsistent with the mass pattern of the organism in trying to establish balances with the surrounds. In other words, I can read, I can write, I can see in a social sense only to the extent to which you permit me to establish freely an organic balance with all the light in my visual field. I can hear in a social sense only to that extent to which you permit me to establish organic balance with the least effort to all the sound in my surrounds. I can develop an acceptable performance, both personally and socially, in relation to the symbols of light and sound, only insofar as you let me find an adequate tension-reducing balance with sound and light in my environment.

It is not the memorization of the symbols that are illuminated that makes for learning. It is the successful establishment of a successful tension-reducing balance with the total light itself and a successful manipulation of the central part of the task where discrimination is being promoted as well. A reflex action in relation to coming to balance with light is to turn and face it. Social demands of the room may require facing in a slightly different direction. When these two reflexes come to grips, the final pattern may be that the child will duck his head in order to compromise between the various stresses set up in his body. We found that most of the difficulties enumerated earlier to be demonstrated in these relatively different stresses set up became strains because of differences in task illumination and surrounds, such as background reflection, blackboards, and other environmental conditions. When we come to balance and are free to perform, we are accommodated, we are in focus with the particular task. When we are out of balance, we may over-accommodate. Therefore our illumination should be designed in terms of permitting the total balance, because accommodation would follow along with the function of choosing that balance rather than of being concerned with the central field area.

We have to remember that the child is really learning to see. The actions of learning are being derived from the mass actions of adjusting and staying in the physical surrounds in which we put him. If the physical surrounds call for too much sustained action in maintaining balances with those three-dimensional energies, the learning will be reduced accordingly. If the energies in those surrounds are out of balance with the way the child comes to balance, the child is going to deviate physically, and as a result of that physical deviation his performance will be reduced. So lighting design is not merely projecting enough light, under proper contrast, onto a horizontal working surface, but it is getting a uniform distribution of light through a three-dimensional sphere so that the child is free to perform without tension. [At this point Dr. Harmon showed a number of slides which

illustrated his talk. Because of lack of space, this information has been omitted.]

To summarize: The human organism strives to grow, develop, and function as an integrated whole. In each of its responses to the forces or restraints in its environment which stimulate it, it performs organically by seeking physical balances with those forces and restraints which meet certain functions on inherently determined systems of coordinates. These responses have a large share in determining the organism's later development, efficiencies, and well-being.

The work environment of the immature organism, that is, of the child, must be equally coordinated with the organism itself if we would have the child arrive at an optimum maturity, fully capable of using its resources and developmental experiences in meeting its needs in an efficient, acceptable, and satisfying manner. The organic child has just so much energy to expend. This energy must go toward satisfying his basic needs in staying alive, converting his food into usable chemical forms, protecting him against infection and other diseases, and growing and furnishing the energy for all the activities and adjustments demanded by his environment. Only a limited amount of his energies is really free for activity.

When environmental demands exceed the energy available for meeting them, the environmental demand is met by depriving some other vital need of its energy. Growth suffers most in most cases. Continued stress induced by poorly designed furniture, by poor distribution of light, or by visual performance demands inconsistent with basic visual performance patterns might readily use energy needed for growth, for body function, for protection against infection, or for overcoming other adverse factors in a child's total surroundings. Bodily growth is inherently a balanced process, but a study of growth shows that its center at any given time is always at the center of the greatest body activity. In other words, the child's body, or bodily system, tends to grow along the lines of stress induced by various activities in order to reduce those stresses. If the environment sets up centers or lines of stress not fitting the alignment of inherent and normal growth forms, the result is structural warping. As the child continues to grow and function in such surroundings, the final result is asymmetrical or unbalanced body structures, deviating performances, or physical or psychological lesions and disabilities.

Health and Development Problems of the School Child

by

DWAIN N. WALCHER

It is impossible for me to cover the health and developmental problems of a school child in 20 minutes. It is assumed that you would like to have these subjects correlated with schoolroom lighting. Un-

fortunately, I cannot do this, and must leave it to you. During the past 10 days I have discussed this subject with pediatricians, an orthopedist, a child psychiatrist, a child psychologist, a physical therapist, members of the State Board of Health, former school teachers, and parents. I purposely omitted the man who devotes himself to the study of abnormalities of the eye, for I have noted this field is adequately covered by other men on your program. Not one of these people felt that he could strike up direct correlations. However, this has been done by Dr. Harmon, whose excellent publications have come to my attention since I turned my reading to this subject. I shall attempt to give you the basic features of growth and development which we, as pediatricians, teach our students.

Admitting there are variations from the normal, it is possible to state that there is conformity to the pattern of general growth. The first period of rapid development occurs during fetal life. This is followed by a decelerated phase through infancy, with the second major growth period occurring during adolescence.

During this first decelerated phase of growth there is gradual skeletal enlargement and an increase in muscle mass and subcutaneous tissue. This is normally associated with improvement in muscle tone and ligamentous support. Therefore, posture and body mechanics come under consideration.

The nerve tissue of the body has a pattern of its own, growing very rapidly during fetal life and briefly extending into the first decelerated phase of the general growth period. The brain is about 25 per cent of its adult size at birth, the body weight at that time being about 5 per cent of the adult weight. About 50 per cent of the remainder of its growth occurs in the first year of life and 20 per cent more the second year.

Lymphoid growth occurs quite rapidly during the first 10 years and immediately regresses thereafter. This may be illustrated specifically by the adenoidal and tonsilar growth. Genital growth occurs rapidly at the close of the second cycle of general growth.

More specifically, the age group from 6 to 12—frequently referred to by pediatricians as the school period—is characterized by a deceleration in growth in height and by an increasingly rapid weight gain. The child loses his lanky, wiry, preschool appearance. The instability of the preschool child gradually gives way to increased stability. In many ways these years from 6 to 12 are more stable than those which preceded them and certainly more so than the hectic years of adolescence which follow. At this point one sees the typical boy or girl, not the baby or little fellow, and not the restless adolescent youth.

During this time he is most susceptible to the common communicable diseases and is frequently exposed to them. Obviously, repeated infections of a serious nature will retard the growth which normally occurs at that time. Much has been accomplished during the past 25 years to reduce the incidence of such diseases as whooping cough, diphtheria, tetanus, typhoid fever, and tuberculosis by immunization or improved public health measures and control. Other serious illnesses, such as scarlet fever, with the resultant draining ears, and

mastoiditis have been largely obliterated by modern forms of therapy. Pneumonia has been changed from a disease with a high fatality rate to one from which we all expect a rapid recovery. There are other diseases such as measles, poliomyelitis, and the common cold for which we have no specific therapy and no known way to immunize or vaccinate.

Certain groups have been carrying on considerable experimental work to see what role aerosol sprays or ultra-violet light may play in reducing the incidence of infections assumed to be air borne. This work has been carried on in hospital wards, in army barracks, in schoolroom situations, and on school buses. An example of such work is that being conducted by Bahlke, and others,[1] a group at Albany, New York. You are probably more familiar with their work than I am. Mumps and chicken pox were reported upon recently. I quote from their conclusions: "These analyses of epidemics of mumps in two of the centralized schools under study offer no incontrovertible evidence that ultra-violet lamps in the classrooms modified the spread of the disease in those classrooms. This finding may indicate that ultra-violet irradiation is ineffective in controlling the spread of mumps, or it may mean merely, as some authorities believe, that mumps is not an air-borne infection.

"On the other hand, the differences in the rate of spread of chicken pox, with low-grade protracted epidemics in irradiated individuals and more explosive episodes in unirradiated controls, may be due to the presence of the ultra-violet radiation. A similar interpretation was suggested in the prior report dealing with measles."

As a result of various infections, hearing may be directly influenced, either by some effect on the nerve, by middle ear involvement, or by blockage of the eustachian tube by lymphoid hypertrophy. If the child has an unrecognized hearing difficulty, he may attempt to compensate by twisting his body to obtain a better vantage position for hearing. His difficulty may be sufficiently grave to prevent any personal compensation, so the child becomes an inattentive pupil who is subsequently a poor student and a problem child for the teacher. Such a vicious cycle may lead to misunderstanding the child to a point where serious adjustmental problems may result.

Returning to comments on skeletal growth, the vertebral bones and ligaments are relatively malleable in the child of school age. The long hours spent in an ill fitting chair before an improperly designed or inappropriately sized desk lead at first to functional and ultimately to permanent structural curvatures of the spine. Postural defects may occur as a result of inadequate hearing or impaired vision. They may also result from other factors, such as chronic fatigue or malnutrition. Schoolyard play is gauged for the average child. The one who exerts himself unduly to keep up may well slump at his desk when he returns to the classroom.

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[1] Bahlke, Anne Magdalen, and others, "Effect of Ultra-Violet Irradiation of Classrooms on Spread of Mumps and Chickenpox in Large Rural Central Schools," *American Journal of Public Health* 39:1321-1330. October, 1949.

With the adolescent spurt of growth, there are many children who develop what the physical therapist calls the "fatigue slump." They become kyphotic (humpbacked) and/or lordotic (a forward convexity to the spine), and thus poor body alignment results. This is more frequently seen in girls, but occurs in boys also. Corrective exercise and attention to nutrition and rest will correct this if given consideration early enough. Photography, movies, and mirror study are all used to aid the therapist in showing the student his poor posture at the beginning and his improvement as time progresses.

Weight gain is relatively greater than height gain in adolescence. The child develops a heavy physique and stocky appearance. There is a sudden spurt of growth in height, which is striking and abrupt; the weight gain is evident over a longer period of time. Maximal muscle growth is late in occurrence. The heart muscle may not develop as rapidly, and the muscular adolescent boy may, therefore, not have a heart proportionately mature.

Leg length increases rapidly during early adolescence, but slows down and ceases somewhat before growth of the trunk is terminated. Skeletal size increases greatly during adolescence.

Primary and secondary sex characteristics develop during adolescence, and are consistent in their sequence of appearance. With all of these changes comes a demand for food. Appetites are huge, and parents must see that an adequate diet—one with liberal amounts of protein—is provided. Obesity may result if proper diets are not provided along with adequate physical outlets.

No mention has been made of the problems of the child with congenital defects. The congenital cardiac may have stunted growth and shortness of breath on exertion. The child with intestinal dysfunctions will suffer from nutritional disturbances. Kidney abnormalities may lead to retarded growth. Skeletal defects and muscle dysfunction may lead to poor posture or inability to move about normally.

Perhaps it has been unwise to dissociate physical growth from mental and emotional growth and development. Child psychiatrists have been teaching us much about this phase of the child's developmental aspects in the past few years. As I read through several books prior to writing these few words I was interested to note that most of the discussion centered about the turbulent period at puberty.

There has been a very striking movement in the last eight years focusing attention on the adjustmental problems of the mother with the infant. Their adaptation to each other should start at birth. The adjustmental phase should be initiated with the assistance of trained personnel who are able to answer immediately the questions which occur in the mind of the mother as each confronts her. Such a movement is now known as the "rooming-in" movement.

It is, therefore, apparent that educators, pediatricians, and parents have now brought everyday child adjustmental problems to a conscious functional level, meeting them openly at the play-school level and carrying them through to the high school age.

Vision, Learning, and Adjustment

SYMPOSIUM

N. C. KEPHART: During the past two years the Morton Elementary School, West Lafayette, Indiana, has undertaken an experimental project in the redecoration of classrooms. In line with this program, certain rooms have been refinished according to the principles of school decoration advocated by Dr. D. B. Harmon.[1] Two such refinished rooms are currently in operation. At the same time, two additional rooms were redecorated in the conventional manner. These control rooms were in every respect comparable to the experimental rooms except that the decoration scheme was of the conventional type.

Studies have been going on over the past 18 months in an attempt to determine the effects of the experimental scheme upon the children. These studies, while as yet incomplete, have been concerned with three avenues of approach: frequency of nervous habits, posture, and academic achievement.

Nervous habits were measured by the method outlined by Olson.[2] Each child was observed for a two-minute period, and each occurrence of a habit on Olson's list was tallied. The total of such occurrences was considered the total score. Reliability studies revealed test and retest coefficients of .77 and .93. Measurements were made at the beginning and end of the school semester in which the experimental groups first entered the experimental rooms. The results are shown in Table 1. This table indicates that the children in the experimental rooms showed a significant decrease in frequency of nervous habits during the experimental period, as measured by the Olson technique.

TABLE 1. MEASUREMENT OF NERVOUS HABITS OF CHILDREN IN EXPERIMENTAL AND CONTROL GROUPS.

Group	N	Measurement		Difference	t-value
		Initial test	Final test		
4th grade control	25	5.56	5.04	+ .52	.71
4th grade experimental	24	6.16	4.30	+1.86	2.11
5th grade control	25	5.54	6.82	−1.28	1.24
5th grade experimental	25	6.68	4.35	+2.33	2.82
Total control	50	5.55	5.84	− .29	.49
Total experimental	49	6.42	4.33	+2.09	3.59

Postural habits were investigated by photographing the child while he was engaged in a standard task. These photographs were sub-

[1] Harmon, D. B., The *Coordinated Classroom*, American Seating Co., Grand Rapids, Mich., 1949, p. 48.

[2] Olson, Willard C., *The Measurement of Nervous Habits in Normal Children*, University of Minnesota Press, Minneapolis, 1929.

sequently projected onto cross-section paper and two lines, one representing the mid-line of the body, the other representing the mid-line of the face were drawn. Those children for whom the angle represented by these two projections was greater than three degrees were considered to have displayed a head tilt.

Such postural measurements were made after 3½ months of school experience. In the control group (N = 25) 40 per cent of the children showed such a head tilt, while in the experimental group (N = 25) 24 per cent showed such posture. These findings, though not conclusive (further measurements are under way), tend to support the results of Harmon.[3]

In June, 1949, one experimental room and one control room had been in operation for a full semester. The children in these rooms were given the Stanford Achievement Test. The mean accomplishment quotient was computed for the group in the control room and was compared with a similar mean for the group in the experimental room. The experimental group showed a mean of 92.1, while the control group showed a mean of 85.4. This is a difference of 6.7, which yields a t-value of 3.49.

JOHN H. WATERMAN: Even though we realize that the child functions as a total organism, in child psychiatry courses we have to break down the operation of a child into various facets for the purpose of study. Dr. Kephart has presented one particular theme of a child's life. You can see, from the small amount of evidence that he has presented, that better illumination and better studying conditions result in fewer nervous problems and fewer nervous habits in a child. Now I wish to take up four main points, which again are a breaking down of this individual from a child who is functioning in an environment and in relation to other people through definite processes and actions.

The first thing is the physical factor. In child psychiatry our first concern is the physical condition of the child. Regardless of what his complaint may be when he is brought before a psychiatrist, his progress in school is immediately investigated. Now you might say, "What does poor progress in school have to do with visual defects?" I do not think I have to elaborate on that too much, because we know that if a child cannot see the blackboard he may well develop a reputation for being dumb, unless the teacher is trained well enough to recognize his visual deficiency. As a consequence, this child might react in one of two ways. First, he might become very aggressive and mean, ready to pick fights, kick other children, and take a poke at them every time he walks past. Or he may be the other type of individual who, under such a stigma, develops feelings of inferiority and withdraws more or less, becoming the kind of a person that gives up easily. This could all happen because of a primary physical factor in the child's environment.

I could go on and name a great many other physical things that could bring about similar difficulties in behavior. I recall that in another state a child was examined by a psychologist who felt him

[3] Harmon, *op. cit.*

to be mentally retarded, which diagnosis was more or less confirmed by the examining physicians. Consequently, the child was sent to a school for retarded children where he remained for six years. Someone in this school took considerable interest in this child and, upon examination, proved that the child was deaf. Further tests showed that the child had an I.Q. of around 120 instead of the 68 formerly rated. A removal of his tonsils and adenoids improved his hearing to a point where he was only about 20 per cent abnormal. He was taken out of this school and returned to his regular school, passed his grades rapidly, and adjusted well to his social life with other children. I cite this as something to remember about the importance of the physical side of children in their total adjustment.

Now I do not mean to say that merely correcting physical defects will be the answer to the whole problem. For instance, in examining children who have had poliomyelitis, we find great differences in their ability to walk. We have found out that, if the mother is understanding and assumes the proper attitude toward the child, the child gets along very well and adjusts himself with practically no difficulty. On the other hand, if the child has an overindulgent mother who has used polio and other defects as an excuse to spoil the child, the child often has to return to the hospital within a short time. There is no need to elaborate further on this factor, because I am sure all of you can readily see its importance.

Another factor which we must consider is the intellectual factor, or, if you want to put it another way, the actual innate ability of the child to do various things or to perform manual tasks intelligently. We would not think of operating our child guidance clinic without psychologists who do the testing of the children to determine their intellectual ability. Psychologists are also very important in determining the emotional factors and emotional strains under which a youngster may be working. Just because a child shows poor progress in school does not necessarily mean that he is retarded mentally. Sometimes he is of superior intelligence, and the class with which he is placed is not a sufficient challenge to make him feel that he wants to and needs to work hard.

We all know repetition is one of the methods of fixing things in our minds. One of the original laws of learning is repetition of materials. Now, brilliant children, who are able sometimes to grasp things very quickly, get the idea without having it repeated. That goes well until the teacher asks him a question the next day. He may get a general idea, or even the right idea, but not be able to retain the actual details.

There is another thing that should be brought out from a clinical point of view, and that is the pupil's I.Q. relative to the I.Q. of others around him. For a concrete example we may find that, in a family where the mother and father are well educated and have high intelligence and two of the children of the family have I.Q.'s around 125 or 130, another youngster may have an I.Q. of 100, which is normal. That average intelligence certainly fits into a large percentage of our population and yet, in relation to the galaxy of stars that he has to live

with, he is a dummy. He becomes a dummy because people throw up to him the achievements of the other children in the family, and he begins to develop the same sort of behavior pattern that I spoke of in connection with a child who has an unrecognized visual or hearing defect. Thus, he may develop aggressively or he may react by withdrawing into himself.

The third factor that I should like to mention in relation to a child is the environmental factor. By environment we mean everything that happens to him, whether it is at home in the family, or at school, or any place else. What kind of a family does he have? What sort of children does he play with? What sort of things does he do going to and from school? What does he read? What games does he like? Sometimes, even knowing the names of the dogs and cats in the family helps in the diagnosis of the child's trouble. We also want to know the opinion of the teachers. How do they feel about the child? All of these things check into his environmental factor.

The fourth and last factor which I mention is the emotional factor. Is he ordinarily aggressive or is he a shy, backward child? How does he feel about coming to the doctor, or about getting into all this trouble at school or with his parents? We listen to the parents' side; then we get the child's story; and frequently we get an entirely different story. We must be very careful to respect a child as an individual. We have to respect the means by which he arrives at his decisions. We can disagree quite often with a child, but, if we let him know that we realize how he feels, he can better accept the limitations placed upon him.

Now I have talked about four factors here concerning the child's behavior, but I again want to emphasize that I have mentioned these four things only as a means of breaking down our thinking about a child in relation to them. However, we cannot actually do that; we cannot break the child down. The child is actually a whole person, living in our world and living with other people as he functions. All change is a moving, dynamic sort of thing. All of these factors are interdependent, and we can never say that just one factor may be causing a child's difficulty. It may be an interaction among all the factors in the whole group. I think I can best summarize by saying that, when you think about the behavior of children, it is important to remember that the causes of behavior are multiple, there is no one cause for behavior.

IRVIN M. BORISH: The relation between visual facility and the rate of achievement is not always direct. If reading is used as a criterion of achievement, the extent of visual impairment, within limits, seems to have little effect upon reading ability, according to Imus, Rothney, and Bear (12), Stromberg (21), Romaine (18), and Goodsell (6). Clark (4) points out, however, that, despite the low correlation, the multiplicity of factors involved in reading or scholastic performance, such as classroom conditions, teaching procedures, emotional problems, intelligence levels, motivation, and many others, would hardly lead to the expectation of a high correlation between visual facility and any

one of them. Nevertheless, one point upon which agreement is found is that visual malfunction must be taken into account in any consideration of reading disabilities.

Clinical data present evidence that correction of visual disturbances frequently results in improvement of reading. The current interest in the importance of vision in reading is partly due to the inclusion of visual development in the growing consideration of the so-called "reading readiness" of the child. Reading readiness, as explained by Harrison (8), obviously includes many other factors besides the visual one. In fact, visual development is merely one of six categories under physical development, which is itself one of three major subdivisions. The interest is also partly due to the very apparent realization that a child cannot read unless he can see, and that the child who cannot see clearly, or hold print in view for any prolonged period or with comfort, must automatically experience difficulty in attempting to read. Betts (1) describes the following three areas of visual malfunction as most important in their influence on scholastic achievement: inability to see the chalkboard or book clearly, inability to maintain single vision, and inability to sustain clear and comfortable vision for more than a short time.

Goodsell (6) quotes A. J. Harris *(How to Increase Reading Ability)* to the effect that an examination of research in the field discloses the fact that studies at the high school and college level reveal little difference in the visual ability of good and poor readers, while studies of students in the elementary schools show pupils with visual defects among poor readers in significantly higher percentages. He suggests that the children with poor vision either drop out of school or learn to compensate by adopting a process which, while violating established ocular hygiene, permits equivalent accomplishment.

It is incumbent upon educators and vision specialists to make systematic attempts to develop reading readiness rather than to wait for it. The progress of classroom development in the use of new methods and techniques designed to facilitate the achievement of the child by eliminating the stresses and handicaps which might retard adjustment, must be accompanied by the obvious alleviation of physical disabilities which neutralize the advantages presented. Insofar as vision is concerned, this calls for adequate recognition by school officials of those instances in which specific visual correction is required.

Besides the obvious symptoms, such as inflammation of the eyes, sties, and so forth, the teacher should be aware of indications in the work of the pupil which might be related to ocular difficulty. These include writing off the line despite corrective practice, poor letter formation, holding reading matter close to the eyes, frowning and squinting at the chalkboard, extreme nervousness, headaches, transliterations in reading and spelling, and odd posture. (The alleviation of this latter in some instances by architectural changes, as described by Harmon (7), should not conceal the fact that head tilt is a common symptom of certain anomalies of binocular ocular coordination.)

Where a student health survey program is utilized, certain of the ocular problems may be recognized before classroom work begins. How-

ever, each new level of accomplishment requires judgment anew of the readiness of the pupil and, with present facilities, this rejudging is seldom attempted. In addition, many of the methods used in such surveys are in themselves inadequate. The Snellen Chart, most commonly employed, indicates little beyond the acuity of distant vision. The Massachusetts Test, a more recent innovation, contains several flaws in procedure and application, and concentrates most of its report upon distant vision and balance. The more elaborate tests, similar to the Betts tests, are more adequate but more difficult to apply. However, even the results of such more comprehensive testing devices as these are utilized upon the basis of the correlation of these results with those found in clinical practice.

This leads to a possible misconception, which is here offered for consideration. Since the norms by which the survey test results are judged do not correlate beyond a given extent with the clinical standards employed by the vision specialist, and since it is these latter standards which are used as the criterion of successful ocular status for the task, a fair proportion of children are missed, either because they pass the survey process with an anomaly which clinical procedure would disclose or because clinical examination does not discover an anomaly which the test procedure indicated. In effect, if the child does not exhibit a visual status which coincides with the established clinical norms for visual acuity, balance of the eyes, range of focus, and so on, he is inadequate. These standards are applied without regard to age, physical maturity, or the performance level to be approached.

The work of Gesell (5) and Ling (13) demonstrates that visual accomplishment follows certain characteristic time sequences. While some attempt has been made to advocate their work as demonstrative of the influence of environmental procedures upon visual development, the more important conclusion to be drawn from their reports is that different stages of visual ability maturate in a certain sequence, that these follow a time lapse which is individual with each child, and that children vary widely in the rate of visual development. The earlier reports of Worth (25) and Chavasse (3) indicate that certain visual functions, for example, fusion, are not fully mature and stable until the child has actually passed the age at which schooling usually begins.

In industry, a criterion has been established for selection and correction of vision for the specific functions of the individual at a specific job. This has been termed "eyes for the job." The standards used have not been the normal clinical standards of "good" eyes, but have been a special set of test results correlated with the achievement of the workers at each job; profiles of ocular status have been established from these which have been used to place new workers at tasks most congenial to them (22). The specific device is not so important as is the testing and statistical work associated with the device for each special application. O'Shea (17) quotes from a survey of increased good workers over the number selected without such a test to show that, when workers were selected upon the basis of these specially designed visual standards, an increase in quality of 64 per cent, in quantity of 56 per cent, and in performance of 42 per cent was revealed.

Weston and Adams (23), reporting the use of special spectacles for hosiery linkers designed not to correct ocular errors but to relieve eye strain incidental to the job, noted an average improvement of 26 per cent, particularly among the beginners or learners. Numerous other surveys report similar results. In addition, of greater significance is the increase in morale, the lessened employee turnover, and the greater safety reported.

It is suggested that an object of research for the combined facilities of the educator and the vision specialist might be an attempt to determine upon a profile for adequate achievement at each learning level, and that the visual readiness of children approaching each level be judged in a manner similar to that used for job placement by industry, that is, by comparison with such a visual profile rather than by standards otherwise developed.

Besides the effect of properly corrected vision upon the achievement of the child, another aspect of the relation between the two is the effect of the classroom upon the ocular status of the child. Numerous surveys, such as those of Luckiesh and Moss (15) and of Hendrickson (9), reveal an increase in the number and percentage of ocular anomalies in the successively higher grades. This has led to a rather widespread assumption that the character of the classroom is influential in increasing the ocular retrogression of the child. Such widespread articles as Maisel's, "What Is School Doing to Your Child's Eyesight?" (16) reflect this assumption.

The requirements of the task of nearpoint seeing, basic to school work, may present a problem which is insolvable by a child with certain visual anomalies, such as fusion instability, so that the child might be caused eventually to compensate by suppressing the vision of one eye. However, the broader implication is that near work, and specifically school work, definitely influences the development of the common refraction errors, particularly myopia. This has, in turn, been followed by the idea that procedures contrary to those to which the school exposes the child, or modification of the existing school conditions, might lead to retardation of the baleful development or even partial restoration of the original ocular condition.

Several repeated and controlled experiments along this line, notably those reported by Woods (24) and by Hildreth and others (10), have disillusioned the adherents of this concept. Stoddard (20) reports Sosby's study of the incidence of myopia under varying school conditions, including some schools meeting modern standards fairly well, and states that the evidence does not warrant the conclusion that any material effect upon myopia is disclosed. The recent notable study of Stenstrom (19) on the causes of refractive error of the eye seems definitely to indicate the preponderant effect of the axial length of the eye upon the nature of the resultant refractive power. This is an anatomical factor which would not appear likely to be altered by the factors involved in nearpoint seeing. As analyzed by Linkz (14), the distribution of refractive errors follows a fairly normal biological distribution curve, and would appear to be influenced more by heredity than by

other influences. Biro (2), as reported by Nagy, substantiates this by tracing specific errors of refraction through three generations.

In commenting on this subject, Hirsch (11) cautions against the assumption of a causative relationship between two factors which correlate highly. The fact that increased close work, as associated with higher school levels of instruction, correlates well with increased ocular anomalies does not establish the fact that the first exhibits a causative relation to the second. Both may be associated with a third unreported factor.

If axial length is the dominant influence on the refractive status, as seems to be fairly well established, then an increase in axial length would be expected with an increase in bodily size of the growing child. Such an increase would tend to diminish the amount of hyperopia and increase the amount of myopia as the child grows older. The increased scholastic load also happens to become applicable as the child grows older. The association of school load and increased myopia may only be related by the association of both with increased age and growth of the child.

Evidence exists to show that some improvement of visual performance can be learned without change in the actual ocular status of the individual. The factors under consideration by school architects and administrators, such as increased lighting, better print, greater contrast, lessened glare, and so forth, can obviously improve visual performance, under those conditions, even without ocular correction.

While the improvement of classroom facilities and ocular anomaly both contribute to achievement and adjustment of the child, the former has been subject to more specific inquiry and application. Improvement is needed in determining adequately "eyes for the school grade." The child with some visual difficulty can be helped by improvement of school facilities but is likely to be better helped by early discovery and correction of a visual handicap, in addition. The effect of poor schoolroom conditions upon the ocular status of the child, in the sense of permanent or structural impairment, is still dubious.

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The Relationship Between Visual Environment and Health

by

DEAN SMILEY

For a long time I have been greatly concerned with the large number of eye difficulties which were apparently directly caused by poor illumination. By poor illumination I do not mean just the failure to project enough light upon the task, but rather the improper balance of all the factors in the visual field. For example, I know of a student who was doing very close microscopic work. He complained of headaches and fatigue. After he was fitted for glasses there appeared to be no appreciable change in his condition. Upon closer observation we found that he faced an open window while working at his microscope. By the way, this is not an uncommon position for microscopes. We then changed his seat, so that the light from the window came from behind, and in a short time all the symptoms of eye strain disappeared.

I remember another case in which a student at a summer camp complained of headaches every evening. This was traced back to staring into the flickering campfire light each evening. Another student suffered a headache after eating dinner under a candlelight. These difficulties came as the result of bright sources of light within the field of vision. The eyes were trying to accommodate to the flickering brightness and the dark background at the same time. As you well know, a constant attempt to make this type of accommodation induces fatigue, headache, and in some cases nausea; therefore it is very important that the proper light source be selected and that it be installed in such a manner as to keep direct glare out of the field of vision. That is why Dr. Harmon of Texas says that it is necessary to keep the proper balance between the task and the surrounding field. For this reason spot illumination and great differences in brightness cannot be tolerated.

In the process of reading, the pupil of the eye and the eye muscles perform countless movements and fixations. In properly balanced lighting conditions, these movements and fixations are kept at a minimum, but in bright lights or in any unbalanced visual environment they are increased, resulting in eye strain and other common symptoms, such as headache, sties, conjunctivitus, squint, sleepiness, and low visual reserve. Dr. Harmon also found in his Rosedale Experiment that balanced lighting improved the posture, refractive error, vision, and nervous symptoms, as well as the accomplishments of the child. He

even went so far as to show that dental problems were reduced through balanced lighting.

It is restful for the body to change positions at intervals. Any type of lighting which requires the body to maintain a particular position for any length of time is bad lighting. As mentioned before, unbalanced lighting can produce contorted posture and stress in various parts of the body. This unnatural position brings unnecessary fatigue, because the energy in the body is being used to maintain the body or help it to meet an unbalanced situation. Therefore, a well lighted room makes for better posture and lessens bodily fatigue.

Various studies indicate that myopia and astigmatism are on the increase in our colleges. The questionnaire sent out to many college students indicated that 10 per cent of those answering wore glasses at 12 years of age, 18 per cent at 16 years of age, and 50 per cent at 20 years of age. In a study of a certain group of New York children it was found that 36½ per cent of the children in grades 1 to 3 wore glasses, 46½ per cent of those in grades 3 through 7, and 68¼ per cent of those in grades 8 through 12. Other studies show that this tremendous increase in the use of glasses does not occur in people who have little schooling or do little close work.

In the Rosedale School brightness balance was brought into being, as well as a reduction of the glare from the natural light entering the room, by installing the proper fixtures, providing more comfortable and lighter colored desks placed in the correct positions in relation to the light sources, and painting the rooms, using the proper light reflection factors. Fatigue was greatly reduced, and nervousness and the upsetting of the whole central nervous system, frequently caused by smarting, aching eyes and chronic peripheral irritation, disappeared. Myopia and astigmatism remained constant under this balanced illumination in contrast to the increase in these visual problems in the normal classroom.

In some of our studies of college students we have been able to trace the cause of poor scholarship back to poor illumination. The students who have had high grades in high school have complained of headaches and eye strain when pushed by the increased requirements of close work and study by college courses, and thus have either had their efficiency lowered or have had a tendency to quit studying. Many other effects of poor illumination on the body have been brought out in your previous meetings, but, to summarize, I wish to say that intensity of illumination is not as important a factor as the proper diffusion of that illumination. There should be a definite balance between all the surfaces in the field of vision. The most common fault of illumination is bright sources of light or glare. Good illumination is more of less inconspicuous and yet requires a minimum amount of body energy for the task to be done in that particular illumination. There is no question but that the cost of good lighting is high, but this cost is very small compared to the loss of efficiency, and the fatigue, headaches, and eye strain. Good illumination is one of the cheapest things that we can buy today.

[When Dr. Smiley was asked questions after his talk he made certain statements, the gist of which follows: He said that, in the opinion of the American Medical Association, fluorescent lighting did not in any way jeopardize vision if correctly installed in accordance with the maufacturer's recommendations. Such lights should be kept a reasonable distance away from the eyes. He also stated that germicidal lights or ultra-violet lamps are still in the experimental stage, and they can prove to be dangerous unless they are installed under competent engineering supervision and are maintained properly. He cited such experiments as the New York State experiment, the experiments in Pennsylvania by William Firth Wells, and some of the experiments conducted by the army.]

Selection and Installation of Good Classroom Luminaires

by

RUSSELL C. PUTNAM

I am very happy to be able to speak to you today on my favorite subject, school lighting, and you can judge that it is my favorite subject when I tell you that I sat up until past midnight visiting with a number of these gentlemen on that subject. Good luminaires are vitally important. The major part of my discussion will be on that topic, but I want to make sure to get it on record that that is not the complete answer. The whole visual field must be considered before the seeing conditions can be satisfactory. In too many cases the selection of luminaires in schools has been made on the basis of the luminaires without very much thought as to the rest of the equipment. When that process is used, even the best luminaires may not give a satisfactory job. On the other hand, we find architects and school men who go to the other extreme.

A few weeks ago I had the opportunity to visit a new four-million-dollar high school. The architect had all the reflectances of the walls, ceilings, desks, and floors set up properly, and it was a beautiful school as long as the lights were not turned on. It seemed that no expense was spared to make this a beautiful school; however, in order to save a few dollars in each room, he had put 500-watt lamps in enclosing globes. The teachers complained about the intense brightness. So, you see, good brightness control is the secret to school lighting, and that is obtained only by the intelligent selection of the luminaires, taking into consideration the other elements in the visual fields.

Too often school lighting luminaires are sold by a salesman rather than purchased intelligently by the consumers. By this I mean that the fixture salesman will come in and sell to the architect or school executive on the basis of price, appearance, efficiency, or some other desirable point, but without regard as to where and how that luminaire is to be used. It may be an excellent luminaire in the proper place, but

it may be a very poor one as installed in this school. I have in mind one particular college building where a normally good luminaire was installed on the ceiling of an entrance hall, approximately 25 feet above the floor. This 40-watt fluorescent fixture had been approved for offices and cafeteria purposes. As you know, although the lamps last a long time, every once in a while they have to be replaced. In this particular place it would be necessary to build a scaffold from the floor to the ceiling and block up the only main entrance to the building whenever a tube replacement had to be made. That definitely is a case where a good luminaire was woefully misused.

Another example of the misuse of a very good fixture is that of the silver bowl concentric ring equipment. The lower half of the lamp is silvered so that the fixture itself becomes a totally indirect unit. It has been found very satisfactory on the west coast and in other schools when properly installed. Later on, the same type of lamp with a spot at the bottom of the lamp was used in the same type of fixture for punch lighting in stores. A number of school men have substituted this combination punch lighting lamp for the regular silver bowl, with the idea that they would get more light directly on the task. Well, it does give more light, but it also gives infinitely more glare, both direct and indirect.

In another instance I had approved a particular lighting fixture to be used in continuous rows running lengthwise of the classroom. These proved to give excellent lighting. About six months later, however, it came to my attention that this same lighting fixture had been run crosswise of the room in a combination cafeteria-study hall. The fixtures were not made to be installed in this manner and, even though the brightness of each unit was permissable when you were looking at an angle or lengthwise of the fixture, it was too great when looking crosswise of the fixture. In other words, I am trying to point out to you that, even though a fixture is good, it must be right for the place in which it is to be used.

The proper engineering approach to school lighting is this: What visual task will the student be called upon to perform? Under what conditions does he write? Does he read? Does he look at the chalkboard? Each specialized room requires an individual analysis. You just cannot make a lot of rules and regulations that will apply to all rooms. For a number of years representatives of 17 major societies and governmental agencies have worked on developing some standards. This work was pioneered by the Illuminating Engineering Society and the American Institute of Architects. No doubt, you are familiar with *The American Standard Practice for School Lighting* of 1948 as published by the American Standards Association. I think it is an excellent guide to follow. It particularly stresses the things we are talking about here today and brings out these new concepts of brightness control. It suggests the skillful use of luminaires, taking into consideration the characteristics of the various surfaces in the classrooms.

[At this time Professor Putnam showed a group of slides.]

The American Standard Practice for School Lighting recommends the limits of brightness ratios. The first one that I want to mention is the limiting of the brightness ratio between the central visual field and the immediate adjacent surfaces. This ratio is recommended as 1 to 1/3, that is, we should strive to keep the brightness of the visual task not more than three times as bright as its immediate background. In this particular case we are saying 1 to 1/3 because we want to keep the task at unity. That immediately calls for lighter desk tops than we have had in the past.

This trend is an excellent trend. Between the central visual field or task field and the more remote areas in our surrounding field, that is, the walls, floors, and other things outside the general desk top, the ratio should not be greater than 1 to 1/10 or 1 to 10. These ratios are practicable and make for very comfortable classrooms. It is also recommended that the ratio between the luminaires and the surfaces adjacent to them in the visual field should not be greater than 20 to 1. Again I wish to say that that is the maximum tolerance, and it would be desirable to have still less.

Now brightness ratios are very important, but they are not the whole story. For example, the brightness ratio outside on a moonlight night is very good and certainly is satisfactory for certain types of activity. But for the type of visual work you do in school you should have a general level of lighting higher than that found on a moonlight night, as well as the proper brightness ratio. *The American Standard Practice for School Lighting* sets up the various levels found desirable. These can be obtained by natural lighting, electric lighting, or a combination of the two. However, we must realize that, if the room is to be used at night or at times when natural light is not available, this whole general level of illumination must be provided by the artificial light.

These general levels of lighting can be easily read by an indicating instrument which is calibrated in foot candles. Brightness readings or brightness patterns are very easy to talk about, and they are the ultimate for which we are working, but they are hard to measure. It takes a comparatively expensive instrument and a trained operator to get reliable brightness readings. Experience has shown us that, if we set up the proper reflectance values in the various surfaces in the classroom, as stated in *The American Standard Practice*, and if the luminaires are properly selected and installed, we will have satisfactory brightness ratios.

[Here, Professor Putnam, by means of slides, showed how a classroom was rehabilitated by the proper refinishing of the desks and floors and repainting of the ceiling and walls with high reflection factor paints.]

As you will notice from the preceding slides, a direct lighting luminaire is one from which from 0 to 10 per cent of the light goes up and from 100 to 90 per cent of the light goes down. The semi-direct luminaire sends 10 to 40 per cent of the light up and 90 to 60 per cent of the light directly down. General diffusion or enclosing globes are

good examples of this latter type of light. You can see that it is just too bright to fit into our recommendations. In the semi-indirect fixture, 60 to 90 per cent of the light goes up and 40 to 10 per cent of the light goes down. And finally, in the totally direct fixture, 90 to 100 per cent of the light goes up and 10 to 0 per cent goes down.

The majority of the installations of today use fluorescent lamps. It has been found that the fluorescent lamp is very efficient and gives off considerably less heat than the incandescent lamp. Because of these facts, as well as for other reasons, it is likely that the major developments in lighting will come in the fluorescent field. There are so many things that we could talk about in regard to the hot and cold cathode, the instant start or standard start fluorescent lamps, the desirability of using four-, six-, or eight-foot lamps, the standard or low brightness lamps, and where the slim line fits into the picture.

At the present time there is a wide choice of lamps and a wider choice of luminaires. It is a very complex problem and there is no simple type of solution. In fact, the longer I work in illumination, the more I realize that it is a job for specialists, that is, a consulting illuminating engineer or an architect who has experience and study in this whole field and who will evaluate the advantages and disadvantages of the different systems for the particular jobs at hand. Remember, again, that the important thing at hand is to get correct brightness balance in the visual fields, and that in order to get that balance, everything in the room must be planned, including the luminaires and their installation. You certainly realize that a mistake in school lighting usually remains a mistake for a long while. Consequently, it is our responsibility to make it right the first time.

[Professor Putnam then answered a list of questions which had been handed him.]

Q. Explain the difference between a 3500-degree tube, soft white tube, 4500-degree tube, and daylight tube.

A. To get the various degree tubes, combinations of different types of phosphors are used. As progress is made in the lamp industry, exact combinations of these phosphors change. In fact, the 4500-degree tube that is now being manufactured has many of the nicer characteristics of the 3500-degree tube.

Q. What is the difference between the hot and cold cathode tube?

A. There is not too much difference between these two tubes; however, it is thought that the cold cathode tube is better adapted to heavy duty situations than the hot cathode.

Q. What is the difference between the slim-line tube and the regular tube?

A. As you know, the regular tube is about four feet long and has two pins at each end and also requires a starter. The slim-line tube has one pin at each end and requires no starter. It can also be maintained in either four or eight-foot lengths.

Q. What type of tube should be used in an average schoolroom?

A. I prefer the newer type 4500-degree tube. It is a little softer than the old 4500-degree tube.

Q. What would you say is the one main characteristic of good lighting?

A. There is no one main characteristic of good lighting. Good lighting should be inconspicuous and still furnish the proper balance of brightnesses within the whole visual field.

Q. How should lights be installed, parallel or crosswise to the sight line?

A. Most lighting fixtures today are manufactured to be installed parallel to the sight line; however, there is one troffer fixture which is very deep and uses a low brightness lamp with no shielding, which is designed to be installed crosswise of the sight line. This fixture should never be installed parallel to the sight line.

Q. Do you believe in photo-electric cells for turning the lights off and on?

A. As you well know, when a fluorescent light is turned on frequently, its total life is shortened; therefore, photo-electric cells may not make for economical installation of fluorescent lighting.

Q. Are fluorescent lights harmful to the eyes?

A. This question was answered last night by Dr. Smiley. Again I wish to say that there is no evidence that fluorescent lights are harmful to the eyes when properly installed at the recommended distance from the eyes.

Q. Can you justify the use of bare lamps or tubes in the classroom?

A. It appears to me that we cannot justify the use of any bare lamps in the classroom at the present time. However, experiments are being made now in using cold cathode tubes at half their rated brightness. Even so, I have no evidence that justifies the use of bare tubes or lamps.

Q. What is the desirable intensity of light in the average classroom?

A. I refer you to *The American Standard Practice for School Lighting.*

Q. What degree shielding would you recommend for luminaires?

A. In my recent experiments we have found that 45-degree shielding parallel to the tube is very desirable. This allows for greater flexibility in seating arrangements.

Requirements of Design for the Curriculum

ROUND-TABLE DISCUSSION

B. L. DODDS: Mr. Chairman, ladies, and gentlemen, I think we should start by introducing our panel. Our discussion group is composed of the two extremes that are involved in the business of school planning—those people who are responsible for educational planning, and the architects who are responsible for translating the educational plans into facilities. To my left, here, is Mr. Frank Allen who is the Superintendent of Schools of South Bend and a man with whom I am

sure most of you are acquainted. To my right is Mr. Legeman, architect from Evansville, and Mr. Simmons, architect from Indianapolis. Our topic is certainly quite broad—"The Requirements of Design for the Curriculum."

As Dr. Putnam was talking this morning, I could not help being impressed with the complexity of education and the complexities in planning buildings. The aspects of illumination certainly involve a cooperative effort between the people who are planning the educational program and the people who have the technical knowledge in this field. It seems to me that we are in something of a revolution, or are at least seeing revolutionary developments, in the whole field of school design and equipment. These changes are coming about because of two things, one is the development of education itself, that is, the increasing scope of educational activities and the attempt to start to plan buildings in terms of the activities that we are going to carry on in them. The other aspect is that of the sheer technical improvements in all of the fields of construction, particularly in the field of illumination. We are at least approaching the idea of a functional school building, starting out with an educational plan, then translating that by the very best of techniques into a usable school plant.

I think I have one particular prejudice in school planning—that is that we must plan the educational program first. I am quite sure that those in school work have not given architects a fair chance on a good many occasions. We simply approached them and suggested that we wanted "a" school building, without having a very clear design in our minds of exactly what kind of things we were going to do in that school. In that situation I do not think you could ever blame anybody except the educators themselves. Unless you have a plan, I think it is literally impossible to expect other people to take something that does not exist and translate it into a functional operation. By way of starting, then, I suggest we start with Mr. Allen, for I know they are planning a number of school buildings in South Bend. What are the kind of features you are thinking about for your school buildings?

FRANK E. ALLEN: The more I attend these meetings and the more I talk to architects and specialists, the more confused I am as a school man. But I feel pretty good about it because I find that even the specialists do not always agree. About 1940, in South Bend, we conceived the idea that it would be better to have several people working on an educational specification than to have only the idea of the superintendent, or of the superintendent of buildings and grounds, or even of the architect. In the Adams High School I think we did a marvelous job as far as the school program is concerned, but I would not want you to visit that school with the idea of seeing how valuable the lighting is. However, lighting techniques have changed since we built that building. In our recent additions we have tried to bring in all the educational features that school people, as well as architects, think should be a part of a modern school program. In the McKinley School, which some of you may have seen, we undoubtedly "have gone all out" on the lighting. We have three rows of lights in each room. Each

one is controlled separately, I think. We have glass blocks, and we have blinds with which you can darken the entire room. The furniture is light colored, the rooms are light, and the corridors are also light. I believe that you can go to extremes on having too much light or too much glare. In other words, even the outside light is sometimes too bright for me. We intend to rehabilitate many of our old buildings, and proper illumination will come first.

MR. DODDS: Mr. Legeman, I am sure you have some ideas here.

RALPH LEGEMAN: Well, I have been sitting here for a good while listening with interest to Dr. Putnam's talk this morning, heartily agreeing with everything he said. I have been thinking that for years the illuminating engineers have been trying to light our schools as they are, not as they should be, to develop the light properly. I think that we should build our schools to house and develop the light rather than try to put in light afterwards. In the first place, in all these pictures that we saw, with the exception of the one with the recessed troffers, we saw all the luminaires suspended on pendants. It has been my thought for years, and the thing that I have been doing where it has been possible in other states, to drop the ceilings to the luminaires and to the top of the windows instead of to suspend the luminaires on pendants. The daylight is absorbed on the ceiling, and we get a much more cheerful effect in the room; whereas, if we drop the heads of the windows as we have done in this room, we are creating a pocket, a dark pocket that we have to illuminate artificially. The second thing is that, by suspending the fixtures, we can give the visual effect of dropping the ceiling.

Other than custom, there is no real reason for high classroom ceilings. They are much too high in terms of the height of children. It is true, however, that we get some benefit from illumination by suspending the luminaire some distance from the ceiling so as to diffuse some of the light on the ceiling. In most cases we recommend 10-foot ceilings for classrooms. Now that is considered low, but it is not too low for a good effect with the windows as I mentioned. I shuddered the other day when I was asked for a nine-foot ceiling in a room. However, on second thought, when I considered the height of a ceiling at home and the fact that we are trying to give the schools a more homelike atmosphere, it does not sound so bad.

Now again, on this subject of illumination, I was very glad to hear Dr. Putnam's comment on the 45-degree cut-off. I have been recommending that for years. The standard fixtures of 35-degree cut-off are good enough for an office, but I contend that a luminaire for a school is not a luminaire for an office, it is a special job. I still feel that, in the luminaire for the school, whether it is fluorescent, either slim-line or cold cathode, we need a louvered bottom and a louvered plastic or transparent side, not an opaque side. Then we could put the fixture directly onto the ceiling. A solid side in the average fixture produces a distinct shadow about three inches from the fixture.

I have in mind another thing: From the standpoint of foot candles, reflecting surfaces, and the like, what does this discussion mean to the

school administrator and even to the architect? To me it means the effect which you get in going into the room. I have seen many a classroom modernized where the intensity is at least 25 to 30 per cent higher than the maintained intensity, which would mean perhaps that 40 foot candles have been put in an old classroom which is modernized in no other way. The effect is quite discouraging. The whole color and brightness balance must be taken into consideration. Partial modernization can be disconcerting. You should not be conscious of any one element in a classroom, you should be conscious of a quietness and harmony and a general effect throughout the whole room.

Mr. DODDS: Mr. Simmons, do you want to add your remarks?

EDWARD E. SIMMONS: Well, I will get back to one of your opening remarks that at this table were the two extremes, the school man and the architect. I would like to stay, however, that those two extremes must work closely together. The architect cannot do a good job unless he knows exactly what the school man is thinking about. To design a classroom we must know what is to take place within the room. The rectangular classrooms, I think, are being replaced by nearly square classrooms now. The old standard was 18 square feet per pupil. Now it approaches around 30 to 40, or even higher in some rooms. To provide enough area for the activities to be carried on would require a tremendously long room if you carried on the same rectangular pattern as before. The other rooms previously designed were more for recitation and study activities, while in the present-day classroom there is a wider variety of activities.

Mr. DODDS: Thank you, Mr. Simmons, I think perhaps that you have stated better than either of us the concept of the modern room. We talked about whether the lighting should be parallel or crosswise in a room. Are we assuming in this that there is a kind of conventional organization in this classroom? At the elementary level you might have a room organized in different ways. You cannot assume that the desks are always going to be running at this angle or that angle, regardless of the degree. You cannot lay out light design, or any other design, on the assumption of fixed seating if you are really going all out for flexibility.

Mr. SIMMONS: I think that the new trend in classrooms presents a more complex problem in lighting than do the older rooms which are being remodeled. I would say that the lighting system should be worked out, after you know the shape of your room and the activities that are going to be carried on. You must also know what type of flexibility you want.

Mr. LEGEMAN: No classroom can be considered fixed today. Three or four rows of lighting parallel to the windows could balance the natural light when properly switched. The low brightness troffer without louvres assumes again that you are going to have the seats in that room in one direction only. You have too great an intensity without louvres if you look parallel to that troffer.

Mr. DODDS: I think it is extremely important to consider the cost. I am somewhat appalled at the situation we face in this state and other states, that is, the need for new school buildings and the limited amount of capital funds. I think whenever you build you accept the hazard of not being able to predict precisely what you are going to want to do in any given structure 25 or 30 years from now. That is very obvious if we look back at some of the buildings which were erected in the 1920's under presumably careful planning. Again, the only defense that I can see is this rather vague thing called flexibility. If you are not too much walled-in, you have the chance to use your building quite flexibly. That is about the only way I can see that you can plan beyond your next 10 or 15 years. What will we do in elementary education? I think a number of us could take a pretty good shot in the dark and get it nearly right, but you are never sure.

Mr. LEGEMAN: Should the public be informed only on costs? I think that our failure to keep the public informed is one of the weak spots in our educational setup. Some of us have talked about our public relations program. My experience has been that the better informed the public is, the better they understand, the more apt they are to support the school. I think that in any community you can have better school buildings and possibly better plans and make them more flexible. It is true you have to consider cost, but I think that, if the people are actually informed, they are more apt to support a more expensive program. However, we are quite weak in this in most of the country.

Mr. DODDS: I think it is important too that we give reasons why. Recently I ran across this kind of reaction, "We are being nice to children," or "It's fine." I think that this business ought to be something more than just being nice. It should be pointed out that this is an educational venture, that the physical and social welfare of people is dependent upon what we are doing. There is still some public opinion to the effect that we have education in nice buildings just because we love our children. Frankly, I do not think we are engaged in philanthropy.

I think this discussion has gone a little off the track. What about the louvered or luminous ceiling? Is it worth the extra cost? (Remarks from the floor)

Mr. SIMMONS: I feel that the installations that we have made are giving us good results and are reasonable in cost. We are all thinking in terms of an ultimate which we will never achieve, but the results are better and better year after year.

Mr. DODDS: We should close, but I think I might try to verify what this gentleman over here has mentioned. I think we are getting some experimental results that seem to show that building deterioration and illumination deterioration are parallel. I am going to be rather arbitrary and close the discussion now with this comment. While we have probably not solved many problems, I think this kind of conference, where we bring together some of the people concerned, is of immense importance and is the only way in which we can really work cooperatively to improve our situation. Thank you.

Lighting and Equipping the Coordinated Classroom

by

D. B. HARMON

In continuing where I left off yesterday morning, I wish to say again that I am not an architect, all I know is children and their reaction within their environment. My experiments have been on children, and I have attempted to design environment where they could grow naturally. There are a number of disagreements between so-called qualified experts. I think that is a healthy situation, because it makes us focus our attention a little more on children and what takes place in the classroom itself. We spend a lot of time talking about environment when we actually are talking about the course of study, and function has been defined in terms of the course of study or the social approach to the educational process rather than of the child's approach to that process.

I think now it is time that we brought into our statement of functions the basic behaviors that the organic child expresses to the physical stimulus in his surrounds. These are the behaviors that we direct into learning through educational experiences. These behaviors we can measure; the developmental factors that lead to these behaviors we can predict. They are responsible for the acts of the child organically; they temper his movements, either to touch or to restrain. These are the things which give us our first basic measurements in developing a classroom, because out of these we get either successful learning or inadequate or deviating developments, depending upon what the physical structure is and whether the behavior brought forth by that physical structure is capable of being directed into successful learning performance.

So I am convinced that the time has come when we have to stop talking about classrooms merely as enclosures and begin recognizing the fact that the classroom is just as much a developmental experience to the child as is the course of study, because that classroom actually sets into action the generalized behaviors that we direct into educational outcomes. Thus I think of the classroom as part of the curriculum.

We have to think of the things that go into that classroom physically in terms of the total experience that the child is going to have in the classroom instead of in terms of some social outcome we expect him to derive from a partial experiment. This is particularly applicable to lighting, because most of our concepts of lighting, as I told you yesterday, are derived from a passive point of view. They are derived from the point of view that we have sufficient or proper light if we set a child in a seat, put a book or sheet of paper in front of him, adequately distribute the light on that horizontal task, and see that glare is reduced so that there is not a washout of the central image.

The only thing wrong with that particular viewpoint on lighting is that it is based upon a fundamental assumption which is not true. Someone brought out this morning that the curriculum is becoming

more informal and the child is centered in one place in the room at one moment and some other place at another time. The development is not only going in the direction of that type of informality where we have different orientations and different centers of interest in the classroom, but it is also going in the direction of the three-dimensional experience rather than the two-dimensional experience on which our present-day concepts of lighting are based.

We have long since learned that we have to give just as much attention to the primary experience in the educational process as to the secondary experience derived from the books and from writing. The socializing of children in these group activities is primary experience, and when we set up standards of contrast limits for classroom illumination we ignore the fact that a different set of limits is absolutely necessary for the primary experiences from which those reading symbols are derived. In other words, we ignore absolutely the fact that we must have three-dimensional experience because three-dimensional seeing is learned before we can convert it into the two-dimensional symbolic experience. Then again, we ignore the fact that, after we have had symbolic experience, we must convert that back into three-dimensional functions. In other words, our normal vision and action is a three-dimensional environment, while our reading and writing is an experience in using symbols in a two-dimensional plane. The contrast of three to one when reading or writing as a two-dimensional experience is not likely to be adequate for performance and activity in a three-dimensional environment.

To throw a little light on cost, which was discussed this morning, I wish to say that I was a state official in my state for a little over 10 years and ran into some very interesting situations. In one of our buildings, with approximately 500 children, our state auditors showed that we were spending a tremendous amount of money through welfare and health services to repair, or attempt to repair, the damage that was being done to children in that school. In fact, these welfare expenditures almost approached the educational expenditures for that school.

Since this was recognized as an average school, we experimented a little. We spent about $5,000 in that building to provide new illumination and to change the surrounds, including furniture. The outcome of that expenditure in one year was to reduce the welfare budget by $14,000; further rechecks showed that that gain was held. So part of the money that should have gone for education was going into the welfare budget to try to rectify difficulties brought about by not spending that money originally for educational purposes. In other words, the taxpayer was probably spending three dollars for repair of damages for every dollar that might have been spent to prevent the damages in the first place. It was interesting to note that in our state the expenditure for protecting the well-being of children was about $.02 a child, while our expenditure to protect the well-being of cattle was about $.10 a head.

I do not think I can stress too strongly to you the fact that the child responds to physical stimuli and to the physical limits of his

surrounds. It is out of these mass responses that we get the discreet behaviors that we direct into education. Every factor in the physical classroom, including lighting, decoration, seating, and so forth, is educational equipment, and as such it must be planned in terms of the way the child grows, develops, and performs. Now, as to the matter of daylight control which has been relegated to a more or less minor role in this conference, I would like to point out that we do not know any one complete answer. We should have considerably more research and evidence before we reach any final conclusions about the exclusion or minimizing of daylight. Because learning is activity and activity implies movement through space, we have to consider lighting from this particular point of view. The human eye is not color corrected like the camera. It does not react the same under dominant colors as it does under equal energy sources. Optically, it reacts in terms of the dominating wave length of the light. If we had a radiation high in blue, because of the lack of correction of the human eye the tendency would be to make the child's eye perform nearsightedly. However, when he went into action he would perform as though he were farsighted in order to overcome that tendency of nearsightedness. Thus, everything that was illuminated by that radiation, high in blue, would be off balance, and the only tasks that he could perform successfully would be those tasks beyond his arm's length. The converse is also true. If the radiation is high in red, the individual statically is in a position as if he were farsighted, but he would function as if he were nearsighted. That is, he could only handle successfully with a minimum effort those tasks that are up close to him.

These are the performances that could be expected from a normal growing child. Thus, it is desirable to confine our illumination for growing children, so far as the artificial light is concerned, to radiation of a somewhat equal energy source. We need the changes that take place in daylight to direct and redirect the child's centering of function throughout the day, with some supplementation of artificial light to blend in with the natural light. We are not quite ready, I believe, to eliminate daylight from the classroom as far as the growing child is concerned. Perhaps sometime we will be able to put all the quality and characteristics of daylight into an artificial source.

Now, if we cannot eliminate daylight, we must find some way of controlling it properly. In other words, we must eliminate the direct glare from the light and use some means of directing that light onto the surfaces where it can become most useful. This optical control of natural illumination has been successful through the medium of some types of prismatic glass brick. Baffles of glass cloth have also given fairly satisfactory results.

Some people have thought that a low contrast room makes for a monotonous room. That is not true necessarily. Contrast is the difference between the amount of light coming back from different areas. It is adverse at any time when it gets outside of the ranges indicated for various tasks of seeing. Luminosity, however, is the entire brightness and difference of various colors. If you use the proper color

chart and know your reflectances, you can select colors which will meet the standards of low contrast and yet give an interesting room.

Many people differ as to whether we should have equipment all of one kind, that is, a duplicate piece of furniture for each child in the room, or whether there should be a great diversity of equipment. For certain activities we need tables with a flat top, that is for the three-dimensional activities. In two-dimensional activities we need tables with a 20-degree sloping top. We also need many other types of equipment in a classroom. With the varied programs we have today, it appears to me to be better to purchase several varieties of furniture for the classroom, with perhaps only 50 per cent of it in duplicate items. I appreciate very much having had the opportunity of participating in this interesting and very informative conference.

Bulletins in the Field of Education, Indiana University

The Bulletin of the School of Education, Indiana University, was first published in 1924 and has appeared regularly since that time. Research studies of interest to educators, proceedings of conferences held, and bibliographies of educational materials have been the principal fields touched upon in these bulletins. A complete list of the bulletins may be obtained from the School of Education upon request. The studies included in the present volume and in the two volumes immediately preceding it in date are listed below. Unless otherwise noted, these may be obtained for 75 cents each from the Indiana University Bookstore, Bloomington, Indiana.

The Effect of English Deficiency Upon a Student's Adjustment in College. By Robert H. Shaffer. Vol. XXIV, No. 1, 1948. 35 p. 50¢.

Planning for School Surveys. By George D. Strayer, Jr. Vol. XXIV, No. 2, 1948. 36 p. 50¢.

An Analysis of Various Factors Associated with the Selection of Teaching as a Vocation. By Robert W. Richey and William H. Fox. Vol. XXIV, No. 3, 1948. 59 p. 50¢.

Some Variations Among the High Schools Represented at Indiana University. By Nicholas A. Fattu. Vol. XXIV, No. 4, 1948. 25 p. 50¢.

Indiana and Midwest School Building Planning Conference: Proceedings. Vol. XXIV, No. 5, 1948. 72 p. $1.

School Library Personnel and Standards in Indiana. By Margaret I. Rufsvold. Vol. XXIV, No. 6, 1948. 38 p. 50¢.

Suggestions With Regard to Some Persistent Elementary School Problems. Vol. XXV, No. 1, 1949. 35 p. 50¢.

Public School Kindergartens in Indiana. By Phyllis Plichta. Vol. XXV, No. 2, 1949. 38 p.

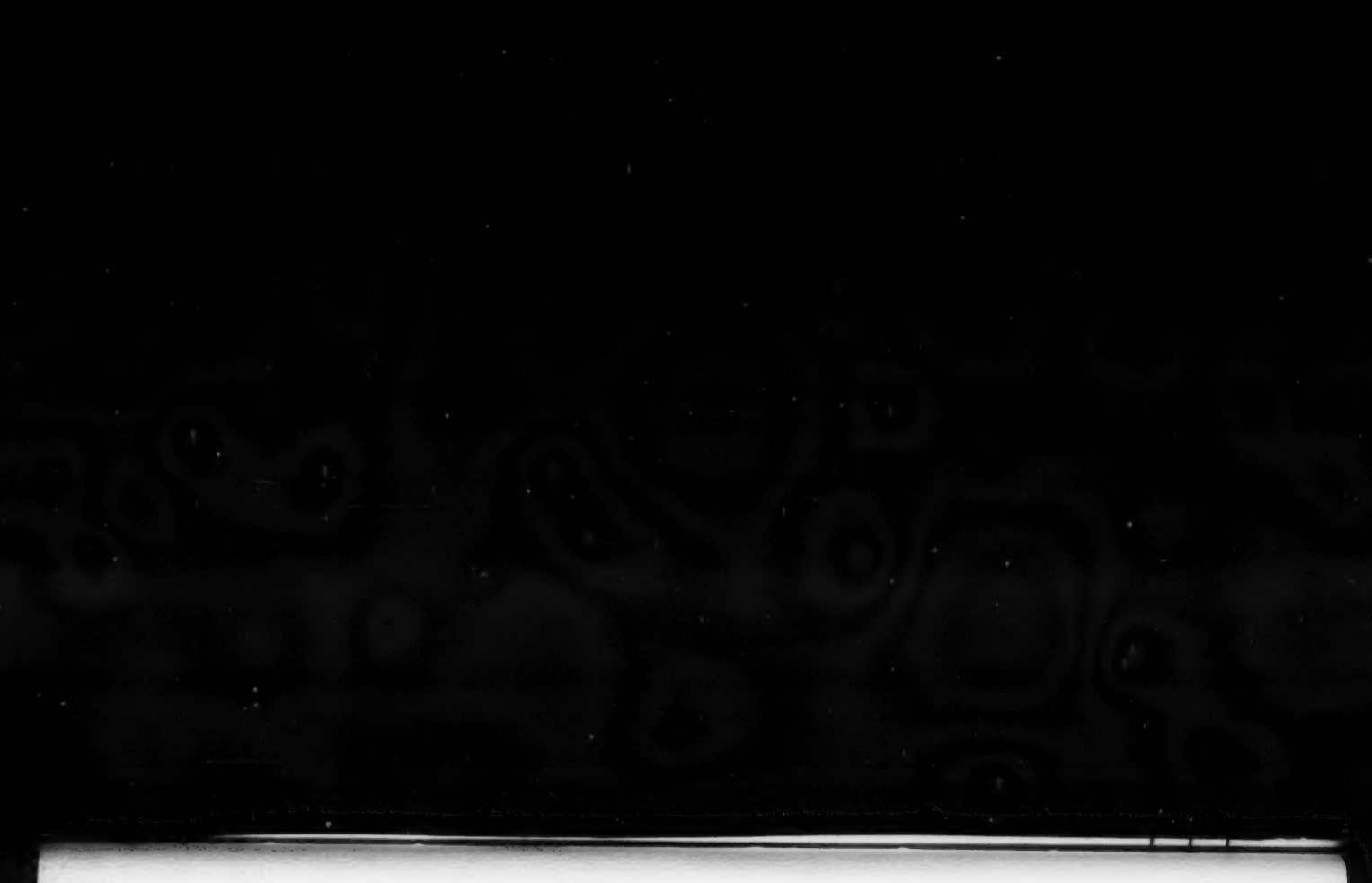
Scores on the Interpretation of Data Test: Their Relationship to Measures of Achievement, Personality, and Interest. By Nicholas A. Fattu and William H. Fox. Vol. XXV, No. 3, 1949. 55 p.

Music in the Elementary Schools in Indiana. By Thurber H. Madison, Dorothy G. Kelley, and William H. Fox. Vol. XXV, No. 4, 1949. 64 p.

Indiana and Midwest School Building Planning Conference: Proceedings. Vol. XXV, No. 5, 1949. 72 p. $1.

A Study of a Secondary School Program in Light of Characteristics and Needs of Youth. By Wilson H. Ivins, William H. Fox, and David Segel. Vol. XXV, No. 6, 1949. 69 p.

Problems in School Administration. By Raleigh W. Holmstedt. Vol. XXVI, No. 1, 1950. 65 p.

Art in the Elementary Schools of Indiana. By Martha R. Carter and William H. Fox. Vol. XXVI, No. 2, 1950. 83 p.

Visual Environment for Schoolrooms (by Paul W. Seagers) *with Proceedings of the Indiana Illumination Conference.* Vol. XXVI, No. 3, 1950. 64 p.